2001-09

Principles for web-based instruction

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THESIS

PRINCIPLES FOR WEB-BASED INSTRUCTION

by

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September 2001

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE September 2001	3. REPORT TYPE AND DATES COVERED Master's Thesis

4. TITLE AND SUBTITLE : Principles for Web-Based Instruction

5. FUNDING NUMBERS

6. AUTHOR(S) Stefanyshyn, Erich I.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING /MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (maximum 200 words)

This thesis presents a set of principles for web-based instruction based on literature from instructional design, usability engineering, and human-computer interaction. A questionnaire based on usability and instructional design attempts to show that in order to improve web-based instruction, usability and instructional design need to be taken into consideration when constructing long distance courses via the Web. The results show that usability and instructional design are dependent upon each other in order to present an effective on-line course while simultaneously learning from it.

14. SUBJECT TERMS
Web-Based Instruction, Usability, Instructional Design, Web Design, Human-Computer Interaction.

15. NUMBER OF PAGES
126

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	A

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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PRINCIPLES FOR WEB-BASED INSTRUCTION

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN COMPUTER SCIENCE

from the

NAVAL POSTGRADUATE SCHOOL
September 2001

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ABSTRACT

This thesis presents a set of principles for web-based instruction based on literature from instructional design, usability engineering, and human-computer interaction. A questionnaire based on usability and instructional design attempts to show that in order to improve web-based instruction, usability and instructional design need to be taken into consideration when constructing long distance courses via the Web. The results show that usability and instructional design are dependent upon each other in order to present an effective on-line course while simultaneously learning from it.

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ACKNOWLEDGMENT

This thesis is dedicated to my wife, Ana Carolina, who has supported and assisted me throughout my eight quarters at Naval Postgraduate School (NPS). I could not have achieved this goal without her constant love and support. I would also like to thank my daughter, Isabela, for her love and patience while her father was studying. A special dedication goes to my father, Michael Stefanyshyn whom I wish could be here to share in this accomplishment.

A special thank you goes out to my thesis advisor, Dr. Rudolph Darken, and my co-advisor, Dr. Anthony Ciavarelli for their research guidance, direction, and mentorship.

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I. INTRODUCTION

A. PROBLEM STATEMENT

Web-based and distance learning techniques are increasingly being offered as alternatives to conventional instruction. Since students now have more opportunities to complete or enhance their education via the web, techniques to attract and retain this large student population are needed. One advantage to asynchronous learning is that it allows class schedules to be flexible. Students are able to view class lectures and other instructional material any time of the day; whereas with conventional instruction, students must be at the specified classroom at the specified time. Another advantage of web-based instruction involves the simplicity of instructions and lectures via class notes and/or video presentation. These materials must be more concise and succinct due to the lack of face-to-face communication between students and professors. Conversely, these advantages can be disadvantages if proper principles are not followed because when students are self-paced, they may lose interest and not complete the course. This is also true with the simplification of course material. If not done correctly, students are not able to extract necessary information with which to understand complex concepts.

B. MOTIVATION

Techniques, for developing high-quality web-based instruction are developed from three disciplines: (1) instructional design, (2) usability engineering, and (3) human-computer interaction. Instructional design principles are basic guidelines for organizing and presenting class material. The overall goal of constructing web-based instruction guidelines is to make an effective learning experience for students.

Poorly designed computer interfaces may impair learning or impede learning progress and efficiency. Usability engineering impacts the quality of instruction because if students cannot use the system, they cannot learn. Likewise, professors cannot effectively present and instruct if they cannot use the system. The professor needs to structure information into the system, and the students need to take the information from the system. The computer cannot stand in the way when users try to get their work

completed. The system must support high productivity. This goal is achieved by designing interfaces that are consistent, controllable, and predictable, which makes it pleasant and effective to use (Schneiderman, 1998). In all, both parties should be able to use the system with relative ease.

Human-computer interaction (HCI) guides the design principles and usability engineering by allowing individuals to communicate and interact with each other by means of the computer. In this case the computer is not only the "middle man" between the professor and the students, but also between students and students. If students, for example, spend more time trying to learn how the software operates rather than learning the course material, they lose valuable learning time, become frustrated with the system, and lose interest in the instruction. These considerations also apply to educators.

The goal of this thesis is to develop a set of instructional design principles for web-based instruction and to evaluate those principles using existing evaluation methods. This thesis will then devise guidelines from the instructional design, human-computer interface, and usability engineering literatures and evaluate the guidelines with a measuring tool to evaluate on-line courses.

It is not the intent of this thesis to find alternative methods of long distance education, but to seek out ways to supplement, complement, and enhance web-based education for students at NPS.

C. RESEARCH QUESTIONS

This research sets out to answer several key questions. First, which principles of instructional design apply to web-based instruction? Since web-based instruction is a fairly new process, there needs to be guidelines for instructors to use when putting a course online. This research intends to introduce a method of derived instructional guidelines from instructional principles for web-based instruction.

This leads to the second research question: Which principles of general web-site usability apply to web-based instruction? In other words, what is the difference between web-based instruction vice general web interaction that makes web-based instruction

special? Users of the Internet equate web-based instruction and general web interaction as being the same when in reality, web-based instruction is taking a formal course via the web, and general web interaction is casual browsing on the Internet. A goal of this research is to clarify the differences of usability between web-based instruction and general web browsing.

Third, which principles of human-computer interaction apply to web-based instruction? Computers are designed for various users. Certain users interact differently with the computer. Understanding human-computer interaction should improve web-based instruction better by helping designers understand how the average student learns via the web. The goal of this research is to clarify HCI principles for web-based instruction.

Fourth, what are the typical capabilities and constraints associated with current web-based instruction software frameworks? When software developers make a long-distance education product, what constraints do they place on the course designer that might inhibit web-based instruction rather than assist students to learn? This research intends to identify constraints and capabilities of software products and how they affect web-based instruction.

Fifth, what are valid measures of web-based instructional quality? Traditional instruction has been around longer than web-based instruction. Solid concrete guidelines have been established to measure the quality of instruction. Regarding web-based instruction, we do not know how to measure the quality of content for web-based instruction. A goal of this research is to find valid methods for measuring web-based instructional quality.

Sixth, how are the data of valid measures of web-based instruction integrated into models to enhance the quality of instructional principles? We need to determine, if we are measuring navigational design, how well we can navigate the Internet and web-based site; or are we measuring the effectiveness of instructional design? Is there a tradeoff between navigational design and instructional design? A goal of this research is to

determine how navigational design and instructional design can be used to improve the quality of web-based instruction.

D. ORGANIZATION OF THESIS

This thesis is organized into the following chapters:

Chapter I: Introduction. This chapter includes an introduction to the problem, motivation, and an outline for this thesis.

Chapter II: Background. This chapter contains pertinent information regarding instructional design, human-computer interaction, and usability engineering.

Chapter III: Theory. This chapter focuses on the theory of web-based instruction and how instructional design, human computer interaction, and usability engineering must be considered when developing a web-based instruction course.

Chapter IV: Pilot Evaluation of Principles: This chapter summarizes a pilot project that initially tested the principles.

Chapter V: Method, Results, and Analysis. This chapter discusses the method of testing, the results, and analysis of web-based instruction.

Chapter VI: Results and analysis. This chapter discusses the results from the survey.

Chapter VII: Conclusions and recommendations. This chapter will summarize the final results and thesis, and provide potential future work that can enhance the efficiency of the questionnaire

II. BACKGROUND

A. INTRODUCTION

In order to understand how instructional design and usability principles are intertwined in web-based education, it is important to understand each component separately. This chapter begins with an overview of human-computer interaction, usability, and instructional design, a discussion on why the areas are not independent of each other in web-based education, and what has been accomplished in web-based education with regards to instructional design and usability.

B. HUMAN-COMPUTER INTERACTION

Dix, Abend, Beale, and Finlay (1998) and Preece and others (1994) define human-computer interaction (HCI) as a "discipline concerned with the design, evaluation, and implementation of interactive computing systems for human use." To produce good systems, HCI specialists attempt to understand how people effectively operate and use computer technology in their environment such as, the work place and home. They then develop techniques to assist designers in making computer systems that provide good interaction between the computer and humans (individual and group). The main emphasis of HCI research and design is to not only place the individual before the computer system, but also keep the individual in mind throughout the entire system design process because in the end, the user has to use the product to accomplish certain tasks.

1. Disciplines that Contribute to HCI

According to Preece and others (1994), 11 disciplines (Figure 1) contribute to HCI; Computer Science, Cognitive Psychology, Social and Organization Psychology, Ergonomics and Human Factors, Engineering, Design, Anthropology, Sociology, Philosophy, Linguistics, and Artificial Intelligence. *Computer Science* is about optimizing computer efficiency; *Cognitive Psychology* characterizes processes (e.g. perception, attention, learning, thinking, and problem solving) in terms of their capabilities and limitations; *Social and Organizational Psychology* studies the nature and

causes of human behavior in a social context; *Ergonomics* (or human factors) defines and designs tools and various artifacts for different work, leisure and domestic environments to suit the capacities and capabilities of users; *Linguistics* applies the scientific study of language; *Artificial Intelligence* (AI) is concerned with the design of intelligent computer programs, which simulate different aspects of intelligent human behavior; *Philosophy, Sociology, and Anthropology* are used to design and evaluate systems in order to provide a more accurate description of the interaction between users, their work, the technology they use in their environment; *Engineering* applies the science to produce an artifact; *Design* assists engineering by providing creativity. (Preece et al. 1994)

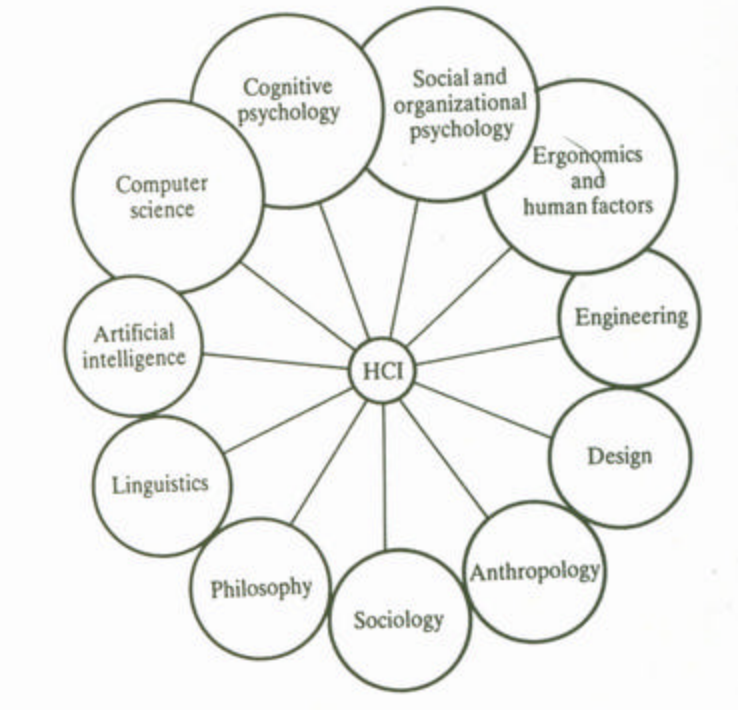

Figure 1: 11 Disciplines of HCI From Preece et al

To produce a system, three unique areas must be combined:

- The 11 disciplines of HCI,
- Tools developed by researchers and consultants based on those disciplines, and
- participation from experts themselves.

Figure 2 shows how a design cycle normally operates. The knowledge and skills are used to develop computer tools. The design team uses the tools to assist in constructing a system or software program. After the system is constructed, an evaluation team will test the system and its usability. (Preece et al. 1994)

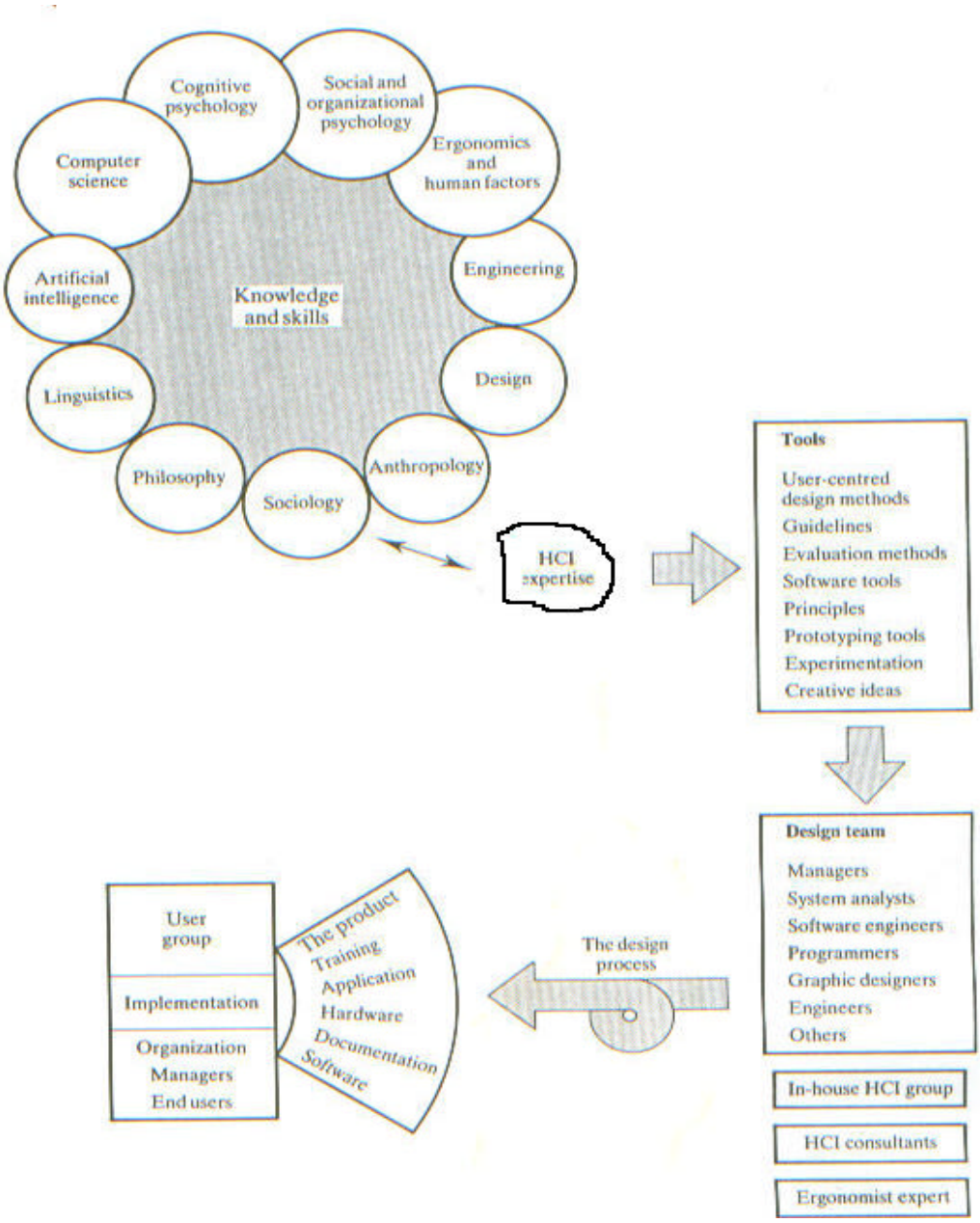

Figure 2: HCI Design Process From Preece et al

2. Incorporating HCI into the Design Process

When contending with HCI design issues, Nielson (1998) and Schneidermann (1998) state that a useful design philosophy for developing user-oriented human-computer interfaces is to consider the computer as a tool to aid the user in accomplishing tasks. A tool that requires more time, training, and effort to use than the task requires without the tool is a poorly designed system. Along the same lines, "Developers of software should not assume that they know what the users do because they are also users. This type of designing has resulted in poor, unusable systems that wastes hours of users' time" (Preece, 2000, p. 112). In all, designers should begin to think like users, who do not care about how the computer operates, but how they use the computer to achieve specific goals.

Incorporating HCI into the design process begins with support from management and input from team members. The teams discuss design tradeoffs that can simultaneously maximize requirements and user satisfaction. This is the foundation for the rest of project and is very critical to its success. Users of the system should be directly involved in the initial design process and during each testing phase. *Knowing the user* is also critical to successful system design. Developers should consult experts and researchers to understand human characteristics. After all, "users come in all shapes and sizes, with different personalities, abilities, experiences, resources, and needs" (Preece, 2000, p. 124). A team of observers should visit the users' work environment to observe and record the users' daily activities and how they interact within their surroundings. This helps developers to *understand the tasks* that users will perform with the system in their environment. *User interface guidelines* should then be developed, documented, revised, and maintained for each project. This helps future projects because a different project team is able to research and understand previous work. When modifying a system, developers also have a base to build upon by understanding how to design within the varying constraints. System and software developers, analysts, management, and other developers should be *trained often in human-computer interface design* in order to increase their proficiency in their area of expertise. Training reinforces understanding and use of interface software tools that enhance the consistency of the interface and provide

an environment where interactive design is simple. It also supports program modularity, software libraries, development time, and cost. These aspects are critical to big projects because they can reduce risk while adhering to the development cycle schedule. *Testing and prototyping* early in the development cycle reveals flaws in interface requirements and user assumptions on how they will use the system. Testing design features should be performed on the intended user population. When changing and refining the design to users' needs, developers should be flexible and patient. Early testing of the design maintains costs and helps the project to stay on schedule. Problems discovered during testing should be revised, corrected, then retested, and documented before continuing onto the next phase, milestone, and project completion. (Brown, 1991; Dix et al.1998; Hix & Hartson, 1993; Preece et al. 1994)

A usability study determines how well designers, engineers, and developers incorporate HCI into their development of a system. This is where HCI envelops usability. HCI existed before the term "usability" came into use. HCI principles are typically based upon a user-centered design process, and certain design (human engineering) guidelines related to screen layout, use of fonts, color, highlighting, etc. Also, HCI concerns itself with the use of input devices, display devices, and their efficacy. Usability engineering, on the other hand, assisted in bringing the idea of a design metaphor into focus and placed greater emphasis upon building uncomplicated menu designs, meaningful control labels, and improving navigation to make systems easier to understand and use. Whereas usability deals with the process of building a system, HCI principles cover the entire design process of building a system.

C. USABILITY

Usability is a key issue in human-computer interaction; it is the principle commonly accepted to indicate the quality of a user interface (Paralangeli, Marchigiani, & Bagnar, 1999). Measuring the quality of the user experience when interacting with a system, such as a web site, software application, or any user-operated device is an example of usability. Nielson (1998) breaks usability into five characteristics; (1) *Ease of learning*; How fast can a new user sufficiently learn the program? (2) *Efficiency of use*;

Once the user learns the system, how fast can the user complete tasks? (3) *Memorability*; How effective can a previous user accomplish tasks with out relearning the system? (4) *Error frequency and severity*; How many errors occurred and how were they recovered? (5) *Subjective satisfaction*; Is the user's experience a positive one? All systems have all five characteristics of usability and all need to be considered in any design project.

1. Elements Supporting Usability

There are three distinct elements that support the usability characteristics. The first element is *learnability,* which is the ease with which new users can begin effective interaction and achieve maximal performance. It is measured by *predictability,* which measures past performance to improve future interaction. *Synthesizability* evaluates the effect of past operations on the current state. *Familiarity* pertains to how users apply their current knowledge and experience to new tasks for effective interaction. Sometimes "guessability" is when users learn something new by guessing on how to use it. If the user is familiar with a product and decides to use a similar product, the user is more likely to have a higher expectation, and is able to "guess" how the new product operates. *Generalizability* relates to how users extend their knowledge of specific behavior to new similar situations. Above all, *consistency* pertains to likeness in behavior arising from similar situations. This is usually accomplished through continuous tasks and keeping the tasks simple and constant. (Dix et al. 1998)

The second element supporting usability is *flexibility.* Flexibility refers to the numerous ways users and the system exchange information. *Dialog initiative* allows users to communicate with the system within a constrained environment imposed by the system. An example is formatting text where users tell the system what font and style they want. *Multithreading* is another form of flexibility where the system supports numerous tasks at a time. Automatic teller machines (ATMs) effectively permit this type of behavior of user-system interaction. *Task migratability* relates to the transfer of control between system and users. The spell checker, for instance, displays a word for correction. After users decide to correct a word, they transfer control to the system for correction. *Substitutivity* refers to how the system can substitute values upon users' requests such as,

changing margins or numeric values. Finally, *customizability* refers to how the users modify their system interfaces to their liking. Experienced users may want more features whereas novice users accept the standard software packages offered. (Dix et al. 1998)

The final element supporting usability is *robustness*. Robustness is how the system supports users to achieve a set of goals. *Observability* affects robustness by allowing the user to evaluate how the internal system operates. Some examples are how well can users navigate, how well do the defaults perform for the users, and how well the system endures through constant use. *Recoverability* assists users in correcting errors where responsiveness is how fast the system can respond to users' intentions. Finally, *task conformance* is how well the system supported the user's goals. (Dix et al. 1998)

2. Usability Standards

Standards are usually set by national or international organizations to ensure compliance with a set of design rules by a large community. The Department of Defense (DoD) requires that software developers be certified according to the Software Engineering Institute (SEI) Capability Maturity Model (CMM). The minimal acceptance for a contractor is level three (defined process). At this level, the organization has a defined process definition and focus of their software development program. It includes a documented and implemented training program, integrated software management, software product engineering, and peer reviews. Generally, the defined process is supported by upper management and throughout the organization.

The International Organization of Standardization (ISO) standard 9241 pertains to usability specifications for hardware and software development design. It gives three specific requirements for usability. The first part is the effectiveness, which is the accuracy and completeness with which users achieve certain goals. Examples of effectiveness include quality of solution and error rates. The second part is efficiency, which is how expended resources relate to the accuracy and completeness of achieved goals. Task completion time and learning time are measures of efficiency. Lastly, satisfaction is how comfortable users feel when interacting with the system. Was the experience positive or negative? (Dix et al. 1998; Schneidermann, 1998)

3. Measuring Usability

Usability testing ensures that all contractual requirements have been met, helps maximize the usability of the system by providing feedback during development, and provides evidence of testing in cases where legal issues may arise. “The greatest benefit about usability testing is that project teams can identify and correct errors, which can help to speed up delivery dates of projects while reducing project costs” (Schneidermann, 1998, p. 128). Varying degrees of system errors are tolerated during testing. However, as the number of system inputs increase, the testing becomes more difficult. Varying degrees of system errors should be capped to ensure maximum usability of the system. Since lines of code are increasing within software programs, it is important that testing be increased and is more stringent in order to find, correct, and reduce the number or errors and bugs within the software development cycle. (Schneiderman, 1998)

System design and tests should include expert reviewers who provide a comprehensive report on system problems and recommendations. Models of expert reviews are *heuristic evaluations*; Expert reviewers critique an interface to determine conformance to a list of established rules. *Guideline reviews*; Experts review the interface in accordance with the organizational guidelines. In *consistency inspections*, experts verify consistency across a family of interfaces, checking for consistency of terminology, color, layout, input and output formats. They also ensure that training materials and online help are also comprehensible for users when they use these services. *Cognitive walkthroughs* take place at each project completion phase and when the entire project terminates. After ensuring that requirements for a phase have been met, experts simulate users performing benchmarking tasks that physically test the requirements. This ensures that the interface is capable of carrying out common tasks. In a *formal usability inspection*, experts hold panel meetings. The individual responsible for the development of code discusses the code before a moderator and a panel of reviewers. Then the panel reviews the presentation and discusses the interface’s merits and weaknesses. These types of formal reviews are scheduled at project milestones, when experts are available, and when the project team is ready. These reviews are for critiquing the product not the individuals who have developed the code. The reviews help the development effort by

finding errors early during development. This ensures that at product completion, the product has no or very few errors, and is usable for the customer. If time does not allow for formal reviews, quick informal demonstrations of the product provide useful feedback. (Dix et al. 1998; Preece et al. 1994; Schneiderman, 1998)

A usability study follows formal testing. During this phase, surveyors test a small portion of end users to determine how effective their products are. The end users are people who interact with the interface, and they determine how well the product could serve them in accomplishing their tasks. Some methods of a usability study are *user ratings* where the user rates a product based on a numeric value. *Surveys* also help developers test their products. Not only do users rate the product, but they also have an opportunity to write comments after each rating. A survey is more in depth than a rating because users explain why they gave that particular rating. Another method to conduct a usability study is through an *interview*. The interviewers can ask certain questions and write down responses to rate the usability of the product, and ask additional questions that might arise during an interview as well as observe and write down comments on how the user interacted with the system. In these sessions, the surveyors are observing the participants' body movements and comments when they are initiating set of tasks. (Preece et al. 1994)

D. INSTRUCTIONAL DESIGN

This section is mainly based upon Charles Reigeluth's book, *Instructional-Design Theories and Models: An Overview of their Current Status*

> In his presidential address to the American Psychological Association in 1899, John Dewey (1900) called for the development of a "linking science" between learning theory and educational practiced (Reigeluth, 1983, p. 5).

Like a jigsaw puzzle, instructional science emphasizes how to put learning models and theories together. Instructional design (ID) links learning theory and educational practice. It is a body of knowledge that prescribes actions to optimize desired instructional outcomes such as achievement and affect (Reigeluth, 1983). Reiser (2001)

states that the field of ID and technology improves learning and performance by encompassing the analysis of learning and performance problems, design, development implementation, evaluation, and management of instructional and non-instructional processes. By understanding instruction and the five processes of instruction, one is able to understand how ID impacts instruction.

1. Five Processes of Instruction

First, instructional theory should not be mistaken for learning theory, which is concerned with what happens to the learner. Instructional theory is concerned with what the teacher does. For this reason, instruction is concerned with "how" to teach. Design falls under instruction because design relates to "what method will the instructor use to teach" (Reigeluth, 1983). Figure 3 shows how design relates to instruction in regards to the education process.

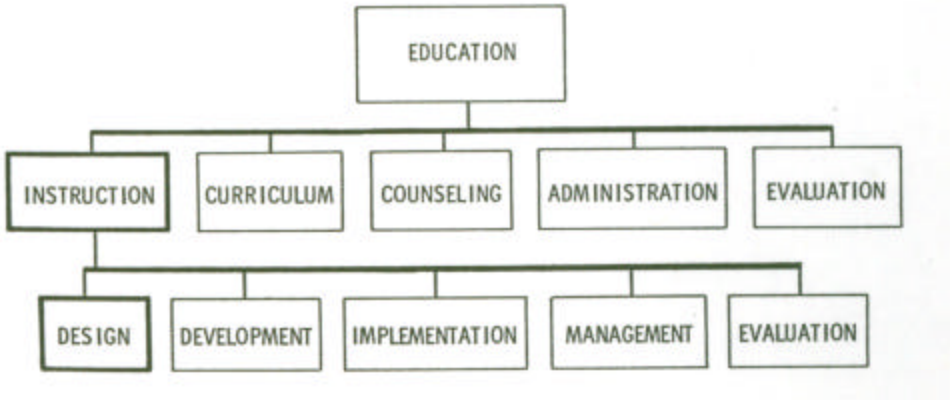

Figure 3: Design Relationship Within the Education Process From Reigeluth

ID involves understanding, improving, and applying methods of instruction. Educators are concerned with what methods of instruction are best for bringing changes in student knowledge and skills for a specific core content and student population. ID is a "blue print" for what method should be used for the course and students. *Instructional Development* takes the blue print and begins building a course upon the design through notes, lectures, and/or lesson plans. *Instructional Implementation* executes the lesson plan. Then *Instructional Management* maintains the lesson through adding and/or

deleting topics to keep it current. Finally, *Instructional Evaluation* is concerned with how effective the design was. Its main objective is to find weak areas to repair. (Reigeluth, 1983)

Of Instructional Design, Development, Implementation, Management, and Evaluation, ID has the most impact on the instruction process because it is the foundation for the development of instruction (see Figure 4).

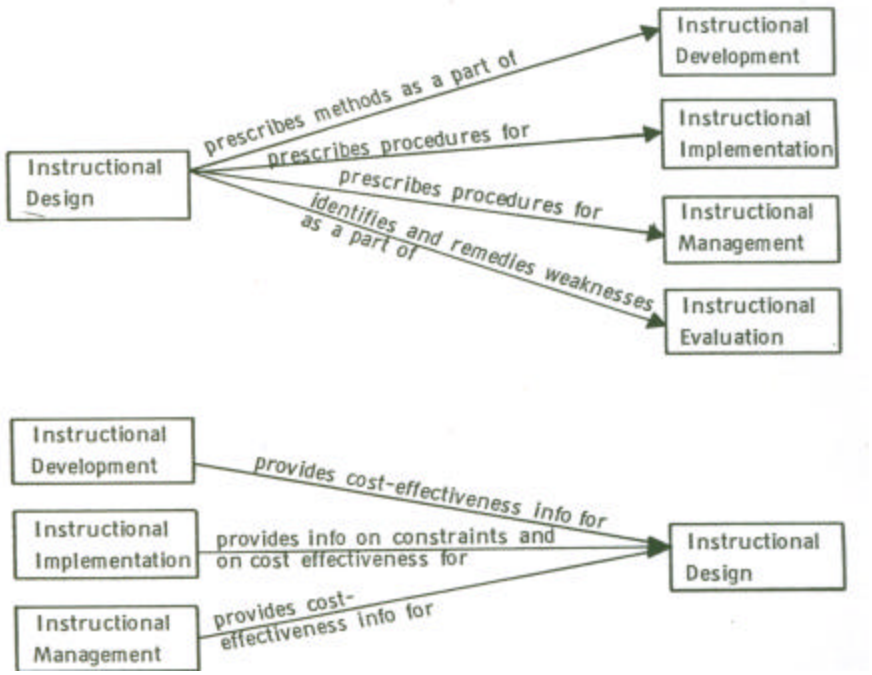

Figure 4: Relationship Between Design, Development, Implementation, Management, and Evaluation From Reigeluth

The other areas are dependent on design as design is dependent on them for input. But the other areas are not dependent on one another. They may build upon one another, but they do not provide input into one another like design does. Design inputs into Development by providing the initial plan to construct something such as web-based instruction. Second, Implementation relates to design by incorporating various methods of design to teach a course. Management manages various methods of design, and

Evaluation identifies and remedies weaknesses in the instructional system. (Reigeluth, 1983)

To be effective, design is dependent upon the other processes. Development provides economical information to the design process. Some designs are more expensive than others to develop and it is up to the administrators to decide what type of design to use. Implementation not only provides an economical decision (because some designs are costlier than the others to implement), but it is also used for constraints. For example, an innovative design may be economically sound, but may be poorly implemented. Management also provides economical input into the design process because if the design cannot be managed properly or it is costly to manage, the design is then rendered expensive and may have an economic impact over the long haul. Evaluation validates how well the instruction was designed, although it does not provide direct input into the models and theories of ID. (Reigeluth, 1983)

2. Models And Theories Of Instructional Design

To make instructional design more effective, instructors need to understand what complete set of strategies provides the best-desired outcome under given conditions or constraints. Reigeluth (1983) describes an instructional model as:

> An integral set of strategy components, such as: the particular way the content ideas are sequenced, the use of overviews and summaries, the use of examples, the use of practice, and the use of different strategies for motivating the students.

Like an architect's blueprint showing many different designs and features of one type of building, instructional design should also show different views of instructions in order to achieve the desired outcome. Each view is a blueprint of what instruction should be like.

These models may be fixed where the same method variable is prescribed regardless of the students' actions. Or they may be adaptive where different method variables are prescribed according to the students' actions. They then build upon a set of

principles that are referred to as instructional-design theory (or instructional theory). Instructional theory is a set of statements that take the form of: conditions-models-outcomes. (Reigeluth, 1983)

3. Evaluating Instructional Design Theory

When analyzing instructional design, two questions should be asked. Is it instructional or learning and how good is it? First, instructional design theory focuses on the methods of instruction and how to manipulate the instructional environment rather than on learning processes. Furthermore, is it a theory rather than a model or a list? Does the theory focus on the pattern of models-conditions-outcomes? For instance, does the theory have one or more models associated with it; does it also have a set of conditions under each model to be used; and does it have outcomes for each model under each set of conditions. (Reigeluth, 1983)

After determining the theory, evaluating it for "how good it is" is the next step taken. Some major criteria to measure instructional theory are:

- *Comprehensiveness*. Does the theory include strategy components from all major classes of methods? Are the boundaries and limitations clearly explained?
- *Optimality or usefulness*. Are there better theories that can achieve desired outcomes? If not, analyze the weak areas on how they can be improved. If so, can they be incorporated into an existing theory to produce a better model?
- *Breadth of application*. Consider all models collectively rather than as an individual model.
- *Parsimony*. Is its degree of complexity warranted? Is it cost effective? (Reigeluth, 1983)

4. Instructional Media

a. Why is the Instructional Media important for Instructional Designers?

Instructional design is delivered through Instructional Media (IM). Reiser and Gagne (1983) define Instructional Media as "every physical means by which instruction is presented to learners. It is every physical means of instructional delivery from the live instructor to the textbook to the computer and so on that would be classified as an instructional medium" (Reiser, 2001, p. 55). In this research, the instructional medium is the computer and the World Wide Web; or the Web for short.

Previously, Phillips (1998) stated that the computer was used as a training tool to fill the void of distance learning. Designers created tools such as, computer-based instruction (CBI), computer-assisted instruction, or computer-based training (CBT), which provided interaction between learner and the content that met instructional goals. However, these tools were rigid due to their lack of openness, flexibility, and the learning environment was only between student and content. (Khan & Ealy, 2000)

The Web, on the other hand, provides an open, dynamic, and flexible learning environment with implications for countless applications with respect to education and training. The Web allows instruction between learner and content, instruction between learner and students, and among the learners (Khan and Ealy, 2000). Also, E-Learning via the Web is potentially cheaper and more productive and can be delivered with more timeliness than either classroom learning or traditional computer-enhanced teaching (Meyer, 2001).

Due to the Web's ability to allow people to communicate economically and relatively quickly with each other in nearly every area of the world, government agencies, corporations, and universities are taking advantage of this instructional medium by placing training packages and courses online. Corporations, such as American Skandia, use e-learning to train and reskill its workforce. Instead of spending days away from their desks sitting in a classroom, employees can log into the company's training site and attend classes during breaks, lunch, and evenings at home at their own pace (Meyer, 2001). The American Iron and Steel Institute (AISI) believes that e-learning not

only saves money, but can also reach entry-level engineers who cannot obtain permission to travel to live seminars, to help them keep current and improve their engineering accreditation. Along the same lines, the American Institute of Architects (AIA) provides the same services for architects. Arizona State University, British University, and the University of Salford in the U.K. offer undergraduate as well as graduate programs for students who are working full time, raising families, and cannot attend classes until 10 pm. When they access the learning sites, the students connect from Malaysia, Europe, or Australia. Overall, the Web provides the flexibility for learners to achieve a quality education at their own time and pace. (Rosenbaum, 2001)

b. How Instructional Designers Use the Instructional Media

Instructional designers should always take into account the person at the other end of the wire and how designers will use the technology to enhance instruction (Khan & Ealy, 2001; Pallof & Pratt, 1999). Learners may live in various parts of the country or world and their technology may vary. One student may have the most recent technology while the other is still using an old source. This may cause a problem for students due to the capabilities of each system. The student with the year 2001 technology such as a Pentium 4, 1.4 GHz can download items and connect faster, whereas the student with the slower and older technology such as an X86 model will take longer to perform these same actions.

In addition to these problems, instructors need to learn how to use the technology in order to deliver the subject material. Will the institution provide sufficient training for instructors to develop and deliver an online course? Will faculty also have trained support if a problem arises with the technology?

Another consideration regarding users (instructors or students) is the amount of experience they may have with technology. Some users may be very adept and are able to catch on to the new technology while others may have difficulties with the technology. For designers, they have to take these two parties and their levels of expertise into consideration in order to produce a successful product.

When using courseware, software developed to deliver instructional material, the Web, CD-ROM programs, or video conferencing, instructional designers recommend that *ease of use* and *visual appeal* be taken into consideration. *Ease of use* is when the equipment is simple to operate for instructors and participants. It should be transparent where it helps the users accomplish their tasks. The hardware should provide enough power and memory to connect to the Internet and make navigating the course site easier. The best method to evaluate a system is evaluating how users comment on the system. Usually, the lack of comments represent that the users are satisfied with the system because it represents that transparency has been achieved. *Visual appeal* refers to the ability to create a site that captures users' interests. Providing space for biographies allows participants to express their personalities and ideas. This assists instructors and students to familiarize themselves with one another and strengthen the lines of communication by putting a face to the name and discussion(s). Virtual reality reduces the creation of a (potential) distorted image of participants. Video games have been doing this for years. The game **Thief**, developed by Looking Glass Studio Creations, for example, provides a brief tutorial on how to use the joystick or keyboard in order to maneuver successfully through the various levels of play. Players think that they are playing the game when in reality they are only learning how to use the game. When it is time to play the game, players are already familiar with joystick or keyboard movements, the rooms, the characters, and the various levels of the game. (Pallof & Pratt, 1999)

E. USABILITY IN WEB-BASED EDUCATION

Research in web-design and instructional design involves many aspects of usability. Nieslen (1998) refers to slow loading pages, obscure site design, and poor support for navigation as serious design flaws that hinder users from completing tasks (Evans, 2000). Hayes (1998) also states that courseware products are chosen based on technical specifications and features rather than on the usability attribute of ease of learning. This attribute should be for both users – the faculty who put the course online and the students who take the course via the web. She stresses that focus for course delivery systems is not given to user requirements and clear operational criteria are not

used. Decisions are often made based on the most recent and available technical information like bandwidth. Overall, Hayes discussed how usability principles can be applied to the web for evaluation, and how they are currently evaluated. Before her analysis of three groupware products, she took into account her target audience (faculty), their goals and tasks. Her analysis concludes that user feedback needs to be consistent and simple so users can easily create links to their files in a timely manner and reduce memory overload (Hayes, 2000).

Parlangeli et al. (1998) discuss how multimedia systems in distance education affect learning. Their interest was in how learners learn to use the computer while learning. Even though multimedia systems are said to be the next major tool that "helps improve learning," their results suggested otherwise. From three experiments dealing with heuristics and end-user evaluations, and a learner assessment based on a long distance class, the authors found that users mainly experienced navigation problems, memory overload, lack of information about the result of their own actions, and difficulty in performing the same actions across different environments. They concluded, "a difficult to use hypermedia system can negatively affect learning performance" (Parlangeli et al. 1998).

Stayner and Procter (1999) deal with navigation, link time, and downloading while using the Web. Even though this study did not specifically deal with usability and educational design, it warrants consideration because of the research pertaining to navigation issues in instructional design. These factors may influence users' choice of which links to follow. Sometimes, it is hard to anticipate arrival times and quality of documents when navigating the Web. Download times are unpredictable and long and quality is usually "bad" if users cannot make it to their destination. Conversely, users will wait for a long link if they know that the material is of good quality. Finally, users have a difficult time planning strategies because the Web is always unpredictable. In order to validate these assumptions, they tested two usability issues: 1. Content; How do users determine the quality of a document? 2. Temporal behavior of linking; How long do you wait for the link? They found that users looked for clues such as, country name, and common names from web sites to determine whether they should proceed navigating the

site, link to other sites for more information, and then they either downloaded items or left the site entirely. Furthermore, some users surfed the Web in the early morning or late at night when run times were better when less people access the Web.

Jones and others (1999) attempted to test the usability of software used for education technology. The main concern is that the educational software is sacrificed for the sake of usability and HCI. They agree that usability and educational technology are dependent upon one another for a web-based course to be successful. However, they believe that the software evaluation process should have more input from educators in order to produce a better product for learners. Comparative studies have yielded information about what has occurred and not how learning has occurred. They believe that there is a need to understand "how the learning occurred" rather than "what has been learned" in order to produce better software for education. By studying the outcomes through interaction and outcomes, software developers and educators together can determine how usability contributes to educational goals.

In other research regarding instructional design principles, Berge (1998), Najjar (1998), and Weston, Gandell, McAlpine, and Finkelstein (1999) mention usability issues such as, technical support, bandwidth, design, and navigation as principles for instructional design. These principles show how instructional design is dependent on an instructional medium like the Web, CD-ROM, or courseware, for its success. Without taking usability into account, educators sacrifice the quality of web-based education. The goal for these tools is to assist the users in presenting a course and taking a course. If these two goals cannot be met, then not only have designers failed by not taking usability issues into consideration, but also the institutions that purchase these tools fail because they have placed the burden on the instructors to deliver a quality education via the Web with a poor product.

III. INSTRUCTIONAL DESIGN AND USABILITY PRINCIPLES

> From a cognitive point of view, the most challenge [sic] is to bring together the *educational content* that students can access in *both synchronous and asynchronous modes* and to unify their respective pedagogical approaches. This merger is possible if an integrated educational approach is taken. In such an approach, the expositive teaching and active learning activities should be combined and balanced according with [sic] their respective pedagogical objectives, their didactic efficiencies, and *technical constraints* (Latchman, Salzmann, & Bouzekri. 1999, p. 252).

A. DERIVATION OF PRINCIPLES

Squires and Preece (1996) argue that thinking of learning and usability as independent issues leads to superficial evaluations of educational reviews and that many teachers are not trained to consider usability (Jones et al. 1999). Usability and instructional design are different fields of study that are dependent upon each other for the success of web-based education. HCI/usability is a procedure that is used to build effective systems while instructional design pertains to what the instruction should be like (Reigeluth, 1983). Combining the two fields creates a good interface/system so that content can be easily accessed, read with ease, and examined with ease. Likewise, the content needs to be just as interesting in order to capture and hold the user's attention regardless of how the system functions. For web-based instruction, Paralangeli et al. (1999) state that the application may offer relevant and useful information, but if the interface is difficult to use, the educational success of the system could be jeopardized. When interacting with [hypermedia] educational applications, the interface guides the student through an educational path. The student thus has to deal with a double learning process: on the one hand, s/he has to learn how to interact with the system. On the other hand, s/he has to acquire new and likely difficult concepts. These two aspects, namely learning how to interact with the system and learning the content it provides are not independent. If either of these balances is disrupted, students will more than likely have difficulties in learning via the web. Instructors may be able to provide good instruction

via the web, but if they are not trained to consider usability when designing a course, their course may be rendered ineffective because of a poor interface and usability. For these reasons, usability and instructional design must be taken into consideration when instructors put a course online. (Berge, 1998; Hayes, 2000; Jones et al. 1999; Paralangeli et al. 1999).

Web-based instruction also depends upon the computer and web design for its success. In traditional education, instructors devise course objectives, print them, and distribute them to the students while explaining them. In web-based instruction, instructors devise course objectives and place them online. Instead of the instructor presenting and explaining the course, the computer now "converses" with the students. The computer acts as the interface between instructors and students. It does not translate "what is meant to be said," rather the computer presents "what is being said" (Eisinger & Smith, 2000, p. 6). To assist instructors in this communication process between the instructor and student via the computer, instructional design principles were collected and derived from the literature.

The literature review indicated that usability might substantially influence the quality and effectiveness of web-based instruction. The readings mentioned "technology minimalism" (Berge, 1998; Najjar, 1998) and "plan the lesson plan to the user's ability skills" (Eisenger & Smith, 2000). Hayes (2000) even stated that despite published reports comparing online delivery systems, "none of these reports contain data about usability testing of the products reviewed. Even so, the phrase 'ease of use' is often sprinkled throughout the reports." These patterns pertaining to both usability and instructional design appeared throughout the readings.

Since traditional education is embedded in the education process, the best approach to web-based instruction was to compare similarities between traditional and web-based education. By breaking down a traditional course into very general parts, the following five areas were created:

- First day of class (welcome to the course).
- This is what we are going to do (administrative).
- Reading material and assignment (presenting the material).

- Assess what has been learned (exam).
- Final course evaluation (assess the course).

B. FOUR REQUIREMENTS FOR AN EFFECTIVE ON-LINE COURSE

1. The System Needs to be Reliable

First, a system pertains to the software, the computer, the server, the amount of bandwidth, the IT (information technology) support to maintain the system, and the training to assist instructors in developing an on-line course. These components ensure the success of placing a course online. Second, a reliable system is outside of scope of this work because we (as educators) cannot tell students to buy the latest and greatest system. We have to hope that students do have a system that functions well. Whatever type of courseware the school purchases, the instructors and students alike are at its mercy. This is where institutions should consider the minimal requirements for web-based courses and the type of technology the users will use to access the course. A conservative estimate of the technology should be taken into account. Usually, the estimates should be the lowest acceptable technology on which the courseware is able to function.

2. The System Needs to be Usable to Instructors

Instructors comment that time and the lack of training are the most common problems in putting an online course together. A checklist that assists instructors with putting a course online could alleviate the time and burden instructors have with putting a course online. A standardized checklist should be created to give instructors the essentials foundations in creating online courses. The difficult part is standardizing a generic checklist to help instructors, so that instructors should not have to be concerned about usability, HCI, and instructional design. Rather, they should be concerned with how to put the math, computer science, or history, course on-line. A checklist designed to cover these three areas would alleviate the problem.

3. The System Needs to be Engaging

A good book will captivate a reader's interest to finish reading the book. Well-designed courses are no different from a good book. In traditional education, good courses are routinely ruined by poor presentation and organization. Students loose interest fast and cannot wait until the semester or quarter ends. In traditional education, the students can support each other through a peer network to help them get through this type of class. But in web-based education, since students are alone, they will turn off the system, and eventually drop the class due to the frustration. To avoid this, the instructor needs to present an organized and interesting lecture. A well-designed course should also engage the learner in active learning processes or activities. The learner should want to study due to the organization of the course and ease of access to materials for learning.

4. The System Needs to be Usable to Students

Of the five characteristics that Nielson (1998) stated -- *ease of learning*, *efficiency of use*, *memorability, error frequency and severity,* and *subjective satisfaction* -- *ease of learning* and *efficiency of use* relate most to web-based instruction. From the onset until the end of the course, students learn and use the system. Any system the students access should be easy to learn and use. After overcoming the initial difficulties in learning, students should not have more problems when using the system. M*emorability, error frequency and severity*, and *subjective satisfaction* depend upon learning and using the system, which come after time and through repetition of use. Only after students learn and use the system, then they can determine how "satisfied" they were with the system. E*ase of learning* and *efficiency of use* are important because they are needed to get the learner started and remain constant for the remainder of the course.

This is not to assume that the student will necessarily learn from a usable system, but that the system should help the student to accomplish intended goals of the course.

These two characteristics also pertain to instructors because they have to put the course online. Since the emphasis of this thesis is placed on how the student can rate a course with a measuring tool, the characteristics will be discussed in this portion of the thesis.

Ease of Learning

Students learn an application while learning new material. It is important to take this into account because new and experienced users alike begin learning a system through trial and error (Hayes, 2000). This means that students are more apt to begin "clicking" features on the interface without reading the instruction manual or the "help" manual, which are normal and curious exploratory procedures that users possess. When users become confused or lost when completing a task, only then do they consult "help" (Nielsen, 2000). The courseware should provide the organizational structure for the course. The courseware needs to be simple and flexible in order for the students to learn the application and for the instructor to design the course.

Efficiency of Use

A system may be easy or difficult to use after learning how to use it. The users may have learned how to operate the system, but continued use of should not be difficult or counter-productive (Wyard & Churcher, 2000). If users have to continually struggle with a system while learning, users may develop a negative attitude towards distance learning – something that should be averted if ease of use is taken into consideration. Firewall access, bandwidth, navigation, and time to wait between changing pages are a few of the technological constraints that can render a web-based course ineffective. Users, regardless of experience, will not tolerate these problems that are associated with the technological medium. Students should be able to use the material with ease or very little difficulty regardless of user ability. (Berge, 1998; Hayes, 2000; Najjar, 1999; Weston et al. 1999)

C. INSTRUCTIONAL DESIGN AND USABILITY PRINCIPLES

By combining the information from the literature, the similarities between web-based education and traditional instruction, and the four requirements of delivering a course, instructional design principles and usability principles were generated. Table 1 shows the principles pertaining to web-based education.

Examples of Usability Principles Pertaining to Web-Based Instruction

Present the material in simple, understandable paragraphs (simplification)
Keep the content as organized and consistent as possible (consistency)
Guide the students from one location to another (navigation)

Examples of Instructional Design Principles Pertaining to Web-Based Instruction

Get the learner started
Present the subject material to the learner
Let the learner assess the subject material
Let the learner assess the overall course
Let the learner assess the usability of the courseware

Table 1: Instructional Design and Usability Principles

D. INSTRUCTIONAL DESIGN AND USABILTY PRINCIPLES DISCUSSION

1. Usability Principles Pertaining to Web-Based Instruction

Present the material in simple, understandable paragraphs (simplification)

"Reducing complexity for users is still a very difficult aspect in interaction design" (Hix & Hartson, 1993, p. 35). After all, the computer is "lecturing" to the student and the student is reading from the computer. Eisinger and Smith (2000) state "the original thought behind online education was to take what was had and put it online". A customization effort was then needed in order to give life to the material, which many people were not prepared to do (Eisinger & Smith, 2000). The content needs to be presented, so that the student does not become inundated with information. Taking into account that nobody can sit in front of a computer for long periods of time without interruption, dividing the learning experience into smaller, more manageable periods of time not only makes sense, but it is easier for a learner to schedule the lesson and retain information (Crawford, 1999; Eisinger & Smith, 2000). The time for reading text, for example, varies among the researchers. Some suggest 15 minutes and then an interactive exercise (Latchman et al. 1999), or 20 minutes and then an example of the text (Berge, 1998); but it should not be more than one-and-a-half hours [combine reading and exercises] (Eisinger & Smith, 2000). In another finding related to multimedia, "reading too much from the CD-ROM was tiring, so students printed some of the material and also requested that the instruction be in printed form" (Jones et al. 1999). In all, the material should not be presented like online books of the past because they are a "well-tried relic from the early days of the Internet" (Aussenhofer, 1999, p. 92) that were difficult to read. Educational material should not be.

Keep the content as organized and consistent as possible (consistency)

This principle reinforces the simple and understandable paragraphs principle by organizing the content and ensuring its consistency for clarity. If the content is not properly organized from the beginning to the end of the course, this distracts students from learning the content because now, students are spending time on deciphering the information. "One of the more important rules in designing instruction is to have consistency among content, instructional objectives, and student practice, all leading to the evaluation that matches the practice on which students have been receiving feedback" (Berge, 1998, p. 73). Organized and consistent content also improves the chances of students comprehending and learning material. One method of ensuring good organization is "asking if content is relevant (value of content), reliable (content accuracy), and up to date (recovery)" (Weston et al. 1999, p.39). In traditional education, when instructors update their courses, they add, delete, and/or revise the content as needed. In web-based instruction, instructors should ensure that the content is neat and current because the content "communicates and teaches" students. After all, the content is the only link that students have to the instructor.

Although the content may be clear, organized, and presented in understandable paragraphs, how is it being delivered? Attention to detail needs to be taken in great consideration when putting a class online because the instructor cannot correct himself/herself immediately after making a mistake (such as, grammar, spellings, etc.). The creativity of organizing the content can be a challenge because something so simple as a misspelled word can distract the student from learning (see Appendix A, section E, project 3: Early Analysis). In addition, strange fonts, lack of indentation, and spacing also cause problems for students. "It is important to ask if a legible font is used (typeface/fonts), whether numbering systems, headings, indentation, and spacing promote consistent presentation (format and layout)" (Weston et al. 1999 p. 39).

Strategically placed hyperlinks also play an important role in affecting how the content is organized. Hyperlinks should be placed at the end of paragraphs after the

presentation of content. This ensures that students read the information first and then use the hyperlink to enhance the subject material. This method serves another purpose. For students who want to continue reading, they can continue the lesson without being distracted by a hyperlink in the middle of a paragraph (See Appendix A, section E, project five: Usability Analysis). For the students who want to enhance their knowledge base on that particular item, they are able to "explore information bases, discover relationships for themselves, or transform and organize information in ways compatible with their own needs" (Astleitner & Leutner, 1999, p. 8). Whether students click on the hyperlink or not, they have read the subject matter without interruptions and they have the choice to view or not view the content (Lund, 1997).

Finally, the number of levels for linking to other sites should not matter if the sites have been organized properly. When Evans (2000), for example, developed guidelines for research-based web design guidelines, she found in one study that people were able to search for information faster and more accurately on bigger systems than a smaller system due to the site being designed to effectively guide users in finding information. The results of the study suggest that, "whether or not a website has been organized in a way meaningful to its users is also a key influence on its usability" (Evans, 2000, p. 305).

Overall, the main focus of organization and consistency is presenting succinct and clear information, which focuses on cognitive and motivational design of hypermedia or web-based instruction (Astleitner & Leutner, 1999). After all, if the content is not organized, then the design of the system and the course is rendered useless (Hayes, 1999).

Guide the students from one location to another (navigation)

Web-based instruction provides numerous benefits such as, quick and remote access to information, convenience, adaptability to change, and speed of communication (Piotrowski & Vodanovich, 2000). However, common design flaws such as, slow loading pages, obscure site design, and poor support for navigation renders the Internet unusable

due to users experiencing delays and running into dead links, which causes users to terminate a task prematurely (Evans, 2000; McKenzie, Mims, Bennet, & Waugh, 1999; Nielsen, 1993; Paralangeli et al. 1999; Piotrowski & Vodanovich, 2000; Stayner & Procter, 1999). These actions show that navigation is vital to the success of web-based education. Instructors should take this into account when they would like to have students visit other web sites. Navigating is the highway to information. Weston and others (1999) define navigation as, "how the student moves through the instruction and how the instruction is designed to facilitate understanding of organization and structure of content." To prevent and/or minimize potential navigation problems, instructors should guide students through lessons by directing them where to go and what to expect. In other words, students open a door to a room (lesson objectives), walk around the room (read the lesson), and leave the room via a different door (perform an exercise or take an exam), and repeat the steps (proceed to another lesson). Informing users about the next site and time to wait to connect or download material, improves the Quality of Service (QOS) that students expect from a course. Sometimes connecting to another site takes time. Users should be able to tolerate delays in connecting because they have been informed about the time lag (Stayner & Procter, 1999). Once again, students should have the choice to continue go to the other web site or continue reading the lesson (Lund, 1997).

2. Instructional Design Principles Pertaining to Web-Based Instruction

Get the learner started

Students should initially meet the instructor and become familiar with the course when they begin. The purpose and goals of the course must be clear from the beginning (Ross, 1999). They should be concise and brief. A description of the "big picture" of the course should be sufficient. The overall goal is to capture students' attention while avoiding information overload (Crawford, 1993). Be creative in explaining the course.

According to Najjar (1999), "this type of instructional design should use a personal style (e.g. personal pronouns, names of specific people, direct quotations, vignettes of famous people) rather than a formal style to stimulate learner interest."

Letting the students feel welcomed may encourage them to become familiar with the web site by exploring the course contents before taking the course (Ross, 1999). By the same token, allow time for an introductory lesson on how to use the web site allows students to relax and relieve the pressure of learning the computer and course at the same time (Astleitner & Leutner, 2000; Paralangeli et al. 1999; Weston et al. 1999). Using the video game **Thief** again as an example, by giving initial tutorials on how the game functions allows users to feel more relaxed while playing the game because they have already been exposed to how the game works.

This area should also be the starting point and return point for students. Inform students that the Home page will be the gathering point for the class. Any new announcements or upcoming events will be posted in this area as the course progresses (Pallof & Pratt, 1999).

Before continuing with the course, students should also know what is expected of them and what the instructor will provide. Usually in traditional education, the instructor explains administrative procedures such as, course objectives, syllabus or class schedule, and expectations on the first day of class in order to provide guidance and understanding for the duration of the course. These routine administrative tasks provide a starting line for students. In web-based instruction, these issues, along with how to navigate the course site, assist the student in becoming familiar and accustomed to the course site and technology. Finally, web-based instruction needs to begin with the end in mind. Course objectives should be established to determine what the students will learn and what skills and abilities they should take with them when they finish the course (Crawford, 1993; Pallof & Pratt, 1999; Ross, 1999; Weston et al. 1999)

For an effective web-based syllabus, weekly topics for discussion and the due dates for graded assignments (quizzes, papers, tests, etc) should be placed in the syllabus section so that students understand how the class will meet objectives because "the

syllabus section is the road the students will take to reach their destination" (Pallof & Pratt, 1999, p. 88). The syllabus should not only be brief to avoid information overload, but it should also be topic-driven to give students more flexibility to use the school's courseware. For example, if the syllabus contains a weekly topic discussion with readings, students have the freedom to read the material, asynchronously post their comments on the comment board, and participate synchronously and asynchronously in discussions before moving on to the following week. If a test is scheduled for that particular week, then students will also have the flexibility to take the test any time before the scheduled deadline (Latchman et al. 1999).

The flexibility that web-based education provides can be abused if there are no defined expectations (Pallof & Pratt, 1999). Course expectations define the parameters or constraints that apply to successfully fulfilling course requirements. They also define what is and is not acceptable. In this section, student evaluation is explained. For instance, how much weight do assignments, tests, and group and individual participation hold? Expectations for participation should also be clearly defined to give students direction and let them know that synchronous and asynchronous participation is just as important as participating in traditional group participation. (Crawford, 1993; Pallof & Pratt, 1999)

Expectations also include course conduct. Conduct is vital because students are more dependent on one another to complete assignments. If there is a team, for instance, and one team member is regularly absent from all team discussions, then the team may suffer due to the lack of participation of one individual. The rest of the team is dependent on this team member who they only know via a computer. Assuming that particular member hinders a group project, the group in general should not suffer due to one individual. Another example of an expectation is how many times a course can be missed before the student is dropped from the course or a grade reduced due to the lack of participation in discussion boards or coordinated chat groups for example. By the same token, students should take responsibility to notify the instructor when they will be unavailable. (Pallof & Pratt, 1999)

Along the same lines, the instructor should define his/her role in the course. Will the instructor organize and present the material, or actively engage the students by participating in group chats and discussions, or will the instructor be a cheerleader, letting the students teach themselves and only help when it is truly needed? The instructor's role should be clear for students to understand the class organization and how it will operate.

Present the subject material to the learner

If the materials are not presented properly, students lose interest. "It is difficult to attend a boring class and even more difficult to attend a boring web site that contains a boring class" (Ross, 1999, p. 3). At the onset, students understand they are about to take the course and begin learning. At this juncture, "instructors shape the course by providing a content-rich resource, which encourages students to explore new avenues of learning" (Latchman et al. 1999, p. 248).

How instructors organize the text influences how well students learn. Najjar (1998) recommends combining graphics with the information to reinforce the content and to focus students' attention on the subject. To reinforce the metaphor, "a pictures tells a thousand words", students take time to interpret what has been read through pictures. Not only are text and graphics easiest to use for on-line environments, but also when they match, students then have a better chance at learning the material (Berge, 1999; Najjar, 1998).

Another consideration for placing text on-line is how students read web pages. Hayes (1999) reports that people do not read web pages as they would print-based materials. Users prefer to scan text rather than read it word for word on the Web (Hayes, 1999). As a result, the overall principles really need to be taken into account when placing the text. For example, after giving a brief review with graphics on the human nervous system, place a web link at the end of the paragraph for the students to explore more. Viewing the web links can be either mandatory or voluntary depending on how much information the instructor wants to present.

As in a traditional environment, instructors should encourage students to be interactive within the Web community. Kearshey (1997) states that, "the single most successful elements of on-line education is interaction among participants" (Berge, 1999; Weston et al. 1999). Depending on the instructor, this method can be synchronous (chat rooms) or asynchronous (discussion boards) or both. Engaging the learner through incorporating activities such as, practice and feedback, opportunities for reflection, and problem solving, greatly enhances the desired learning. Interaction provides an outlet for all students to voice their opinions (Astleitner & Leutner, 2000). It is also good for collaborative learning, since many students are more comfortable with contributing to a discussion on their own terms, with ample time for reflective responses, rather than to being put on the spot in the live traditional classroom (Latchman et al. 1999; Ciavarelli, 2001). With on-line learning, the shyer students now can express their opinion without being stifled by the more expressive students.

Interaction also helps students to develop their logic and thought processes by constructing through rehearsal, argument, and persuasion on discussion boards or in chat rooms (Berge, 1999). Instructors should have the students put their thoughts on the discussion board for other students to see and for peers to comment on. Along the same lines, Jones and others (1999) affirm that through interaction, writing messages help clarify students' thoughts by developing arguments and building upon other students' contributions.

Bosco (1986) and Fletcher (1989, 1990) examined 75 learning studies and found that participants learned material faster and had better attitudes toward learning the material when they learned in an interactive environment (Najjar, 1998). When presenting materials, instructors should stress interaction and make their lessons more topic and discussion driven rather than just having students clicking on the site, reading the notes, and then clicking off the site (Berge, 1998).

Instructors should take into account the time factor and information overload when they present materials. Students cannot participate effectively in chat rooms and homework assignments due to time constraints and the amount of work given. The amount of reading, discussions, and assignments should be distributed evenly for students

and the amount the student should give to the instructor should not overwhelm the student. Information overload inhibits students from learning; thus information should be given and performed in understandable paragraphs and within a reasonable time frame (Crawford, 1999; Ciavarelli, 1999).

Let the learner assess the subject material

This area demonstrates how well the students comprehended the subject matter. The instructor should divide the course between quizzes, tests, term papers, individual participation, group participation, and/or project assignment(s). Najjar (1999) says that, improving student learning performance results from the test matching the information that was learned and the given test matching the expected test. When the instructor decides on the type of assessment, it must match what was taught in the course. Like traditional education, students do not enjoy being told that the exam will be on *subject x* and the instructor gives an exam on *subject y*; or the lesson was on identification of body parts and the test is about the functions of body parts. In all, give the students what they expect because they cannot ask the instructor immediately via the computer as they can in traditional education. (Weston et al. 1999)

Let the learner assess the overall course

Feedback is essential for improving a poorly designed course. The main concern should be how the students experienced the course, the instruction, and the online experience. Giving students a means to respond via e-mail or a questionnaire builds a stronger, cohesive on-line community, since the students have more input and feel "equal" with the instructor (Astleitner & Leutner, 2000; Crawford, 1999; Jones et al. 1999; Pallof & Pratt, 1999). In a traditional setting, students see the teachers, and make personal comments about the instructor when evaluating. They make it personal. In web-

based instruction, the evaluation should reflect the course material rather than the personality, resulting in better feedback for the instructor to enhance the course for the next group of students (Astleitner & Leutner, 2000; Pallof & Pratt, 1999; Rockwell, Furgason, & Marx, 2000). Furthermore, on-line evaluations may be more effective because the quiet students may contribute more anonymously without intimidation. (Berge, 1999; Pallof & Pratt, 1999)

Let the learner assess the usability of the courseware

The instructor should have the students provide evaluations at the end of the course to determine the ease of access to the program, delivery of the material, and technical support. The technology should meet the students' needs because the functionality of the system is just as important as the design. (Hayes, 2000; Jones et al. 1999; Lund, 1997; Pallof & Pratt, 1999; Ross, 2000; Weston et al. 1999; Wyard & Churcher, 2000)

The faculty should evaluate the technology as well to determine how well it worked for them. They should also evaluate for additional training. They should critique how well the institution provided assistance to the instructors. The instructors cannot put a class online without assistance. If the institution is determined to have successful web-based education courses, the institution should ensure that instructors receive the support and training. Some forms of assistance are online help from the vendors of the courseware, tutorials, guidelines from trainers, and workshops (Hayes, 2000; McKenzie et al. 1999; Pallof & Pratt, 1999; Piotrowski & Vodanovich, 2000; Rockwell et al. 2000; Weston et al. 1999).

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IV. PILOT EVALUATION OF PRINCIPLES

To test the principles, a pilot test was conducted. The goal of the test was to find and correct deficiencies in the principles. The project began by identifying and defining the problem. The Naval Postgraduate School (NPS) has been actively developing new online courses, but lacks an effective tool to measure its long distance program. The solution was to create an online course based on the principles, and test its effectiveness. Instructors and students were the intended audience. Appendix A contains the project in its entirety. This section only provides a brief overview of the project.

A. PROJECT SUMMARY

After conducting the needs analysis, user analysis, and task analysis, requirements for designing and building the course were gathered for the design. Using paper, crayons, and pencil, a design of various interfaces with subject content was made, and then shown to various subjects for their critique. The course was a tutorial on using various Internet middleware. The tutorial had a page for each welcome, administrative, course objectives, syllabus, and assignment sections. The learning lesson was also included.

When this design was shown to potential users, they commented on how the navigation buttons should have been placed in a different area rather than on commenting on the content of the course. As a result, various questions on usability of the interface were asked to determine how it affected usability and learning. After making corrections based on the peer review, the design was transferred to the school's courseware for a live demonstration.

The criteria for evaluating the design was based on how well the students could navigate the site by following instructions. Since the school already had a proven and usable system that could deliver the course, the researchers decided to test the content of the course to see if the design also affected how students learn.

B. METHOD OF EVALUATION

Four subjects took a web-based course tutorial regarding Internet middleware. The subjects had at least intermediate computer experience. Four students belonged to Computer Science, Information Technology, Systems Management, and Operations Research curricula. The subjects had a strong background in using computers and one student was also taking an online course delivered via a different courseware tool that was not used in the research.

Since the course material could only be evaluated through subjective means, the research placed emphasis on collecting data on following course instructions, mainly through navigation. The subjects were encouraged to talk and think out loud. As they took the course, they talked and thought out loud so the researchers could subjectively analyze how the subjects' understood the course content. The course time was 30 minutes. During this time, the researchers wrote down their observations, the subjects' comments, and actions as they navigated the course. When they finished the course, the researchers spent 20 minutes with the subjects to evaluate the course via a checklist. The checklist acted as a survey or post questionnaire. After each interview, the researchers and each subject evaluated and reviewed the checklist to obtain better results. The results were based on how they viewed the course when they were taking the course. Another reason why the researchers walked the users through the questionnaire was because it stimulated dialogue on what the users thought of the course. This was better than just "checking the boxes". Furthermore, It assisted them in commenting on their experience. All in all, they also felt more relaxed during the dialogue, which provided the researchers with valuable feedback. After each session, the results from each researcher were discussed and compared. One researcher usually recorded a comment or behavior that the other researcher did not notice during the interviews.

C. LESSONS LEARNED FROM THE INITIAL EVALUATION

1. Instructional Design and Usability are Dependent Upon One Another

As each subject took the course, they commented not only on the contextual errors such as, misspellings, grammatical errors, lack of font and indentation, but also on

the brightness of the screen, the button colors were to bright or dark, and the navigation was difficult, especially when the subjects left the tutorial and visited the web sites. The students did not know when to stop navigating and return to the tutorial. Even though the emphasis of the evaluation was placed on the presentation method, usability issues crept into the project, which reinforced the belief that usability and instructional design are dependent upon one another.

2. Flaws in the Questionnaire's First Draft

The students had difficulties in understanding the questionnaire due to the poor wording of questions. They did not accurately reflect what was intended for the research, since the subjects were repeatedly told to perform various actions again and the subjects also commented on how to interpret the questions for answering.

Another mistake the questionnaire contained was the rating system. The researchers did not have experience and skills required to develop a rating system. To compensate for the lack of experience, the researchers used phrases such as; '1 = strongly disagree', '2 = disagree', '3 = no idea, not really', '4 = agree', '5 = strongly agree, I feel great'. The wording confused the subjects because they did not understand 'no idea, not really'. Moreover, no previous method for quantifying 'no idea, not really' existed. As a result, the initial rating system distorted the accuracy of the data due to using an unproven rating system.

D. QUESTIONNAIRE REVISION

1. Sections and Wording Revision

The instructional design sections were shortened from five sections to four parts. The Administrative and Welcome section were combined into the Getting the Learner Started section in order to provide greater clarity for the users. Also the wording within the questionnaire went through numerous drafts. After each revision, an informal review consisting of NPS students who had taken web-based instruction and NPS instructors who have given online courses, reviewed the questionnaire for more revisions. Due to

their input, the questionnaire evolved into a more-focused and accurate tool. Appendix B contains the revised and completed questionnaire.

2. Replacement of the Rating System

To make the instrument accurately reflect the measurement dimensions, the Questionnaire Interaction Satisfaction (QUIS) version 7.0, developed at the University of Maryland by a team of researchers in the Human Computer-Interaction Interaction Lab to measure users' subjective satisfaction with specific aspects of the human-computer interface, was adopted. This particular questionnaire addresses reliability and validity problems found in other satisfaction measures, and is highly reliable across different spectrums of interfaces (Norman, Schneiderman, Harper, & Slaughter, 1998). Appendix C provides a deeper insight into the QUIS survey.

The flexibility of QUIS was also a factor in using the questionnaire because there were many sections that the project did not use and they were easily omitted from the Instructional Design – Usability Principles questionnaire. The QUIS dealt specifically with the system and delivery, whereas the Instructional Design – Usability Principles questionnaire also needed to specifically focus on instructional design issues. Adopting the QUIS format provided structure for the Instructional Design – Usability Principles questionnaire provided this flexibility.

Another appealing aspect of the QUIS questionnaire was the 9-point rating scale. The scale goes from one extreme such as, 'illogical' to 'logical'. The midpoint of the rating scale (5) can be used as a criterion representing an average. Above 5 is considered being better than normal, and below 5 is considered less than normal. By plotting the results and finding the mean, the reliability of each variable can be determined as well as identifying flaws in the system and the questionnaire. If there are unusual rankings, the graphing will assist in identifying areas for analysis. (Norman et al. 1998)

V. METHOD OF EVALUATION

A trial evaluation was conducted to evaluate the revised Instructional Design–Usability questionnaire as an effective measuring tool for web-based instruction. The subject pool consisted of resident and non-resident students from three classes using the Web as a mode of instruction.

A. SUBJECTS

The first class, SS3011, Space Systems Technology and Applications, was a purely web-based course involving students from NPS and throughout the United States. The second course, OC2022, Scientific Fortran Programming, consisting of five students, was a web-enhanced course, where students went to classes and used the web as an enhancement. The third class, MN3384, Acquisition Production and Quality Management, contained two sections. The first section consisted of resident students and the second section was delivered via Video Teleconferencing Environment (VTE) to students in Huntsville, AL and Fort Monmouth, NJ as well as resident students. The two sections were also web-enhanced. Of the 48 students from both MN3384 and OC2022 who attended lecture and used the Web for laboratories, tests, and homework, 28 students took the survey.

B. INSTRUMENT

The Instructional Design-Usability questionnaire consisted of 83 questions involving questions based on the background material and derived principles involving instructional design, usability, and web design. Two questions related to demographics in order to identify the classes and how the class was presented. The rest of the questions pertained to the questions regarding usability and instructional design. Appendix D provides the questionnaire used in the survey.

C. PROCEDURES

1. Administration

The questionnaire was administered via the Web in June, 2001 to the students. The personal information gathered from each student was limited to the name of the class and if the class was delivered via purely web-based or hybrid. There was no other personal information collected that could potentially relate the participant to his/her responses.

2. Preparation and Evaluation

Because of its length, the time to take the questionnaire was estimated to be between 20-30 minutes. A brief explanation was given to the students regarding the importance of the survey and asked for their honest opinion about how the course was presented. The questionnaire was filled out on a voluntary basis. Twenty-eight (28) students responded.

3. Medium

The NPS Office of Strategic Planning, Educational Assessment and Institutional Research (SPEAR) converted the paper format of the questionnaire into a web-based survey through the software Survey Said. The software creates and processes surveys online. Once the questionnaire was placed online, the students were sent the URL address to take the survey. The answers were recorded into a database and interpreted using an Excel spreadsheet, and then graphed by conditions using the program Stat View. Responses with ' Not Applicable' were omitted from the calculations to provide accurate data for the average. The results are tabulated in appendix D.

4. Evaluation of the Questionnaire

The questionnaire was evaluated in part by how the students rated the course. The intent was to demonstrate the derivations of the average means from each class above and below a criterion, and then make an analysis of how the courses were rated. Since the rating scale is based on the QUIS 7.0 system of 1 to 9 (APPENDIX C:

QUESTIONNAIRE FOR USER INTERACTION SATISFACTION), the midpoint (5) was the criterion for a neutral rating. If the rating was above 5, then the rating can be considered above average and better. If the rating is below 5, then the rating could be considered negative if the questions written to be positive. For instance, in part four of the questionnaire, a question such as “there were difficulties with navigation?” is not negative if the rating is a 2. Regardless of rating, the questionnaire attempted to reveal how groups rate particular parts of an online course.

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VI. RESULTS AND DISCUSSION

A. RESULTS

Appendix D, section A shows the questionnaire used for the survey and section B contains comparison graphs between the two groups. Graph 1 shows the average mean of each section of the questionnaire. Graphs 2-5 show the cell mean of each question from each section of the questionnaire.

The results from the questionnaire (Appendix D, graph 1) indicate that the VTE/online group enjoyed a higher degree of user satisfaction than the hybrid group. The standard deviations between the two groups were between 1.5 for the first three sections, and 2.5 in part 4. In sections 1 to 3, both groups rated the course positively. However, in part 4, the hybrid group rated the usability of the courseware more pessimistically than the VTE/online group.

1. Part One: Getting the Learner Started

Graph 2 shows that the hybrid group had more difficulty in understanding course concepts. The average cell mean difference from questions 4-12 was 2. The class syllabus and course expectations were not as clear for the hybrid group as they were for the VTE group. Both groups agreed in question 13 that the content from the web site was meaningfully labeled. However, both groups differed again on how the web designs of the class syllabus and course expectations were presented on the course site.

2. Part Two: Presentation of the Subject Material

Graph 3 shows that both groups were consistent in their ratings of questions 21-42. Despite some exceptions in questions 29-30 and questions 35-38, where the VTE students rated portions of the course slightly lower than the hybrid group, both groups answered positively on the instructional quality of the course. However, questions 44-51 show the ratings dropping and fluctuating between both groups where the VTE students rated lower than the hybrid group and then returning to consistency in questions 51-53.

3. Part Three: Assessing the Subject Material

In graph 4, both groups rated consistently high with the exceptions of question 59, which had a cell mean of 5 for the hybrid group and 6 for the VTE group, and question 61, which had a cell mean of 3 for the hybrid group and 1 for the VTE group.

4. Part Four: Assessing the Usability of the Courseware

In graph 5, the VTE students rated higher than the hybrid group in questions 68-71. However, questions 72-80 show the VTE group cell mean average dropped to 2, whereas the cell mean average for the hybrid students dropped to 4.5.

5. Conclusions

The questionnaire displayed its potential to be used as a checklist for instructors. In areas such as question 5 (appendix D, graph 2), upon review, the instructor understood why both groups rated the question relatively low. This is an example of how the rating scale and the anchoring words provided solid measuring support to reveal positive areas as well as negative areas.

Despite the positive areas, the questionnaire also revealed a limitation by not providing evaluation items for the questionnaire itself. There was no mechanism added into the questionnaire to determine if the questionnaire is an effective measuring tool. Since numbers can be interpreted many ways, there needed to be a section asking the students about the tool itself.

Furthermore, the volume of low responses indicated another limitation. This questionnaire would have been more effective if there were more participants. One class failed to take the questionnaire due to an administrative error, and the number of students from another class was too low to use as a case study. In the third course, MN3384, 24 students responded, which provided a good assessment of the course and how it could be improved.

Since the students came from either resident web-enhanced (hybrid) or non-resident (VTE web-enhanced), the responses provided a means of categorizing and analyzing the results based on these two conditions.

B. DISCUSSION

The data collected during the course of this study reinforced the instructor's opinion on problems that he encountered with his web site during the course. In a post-survey interview, trends from selected questions were discussed to determine what were the causes and solutions to the responses.

The results in graph 1 (Appendix D) show that the VTE students had a higher level of user satisfaction throughout all areas of the questionnaire. This could be attributed to the instructor not being physically present, thus forcing the non-resident to concentrate more on the material than the resident students. Furthermore, the VTE students currently work in the field of acquisition and were already familiar with the lecture material from the course. As a result, they could easily apply lectures and assignments to a daily routine whereas the resident students were in the process of learning new material and lacked the work experience.

The quotes from the discussion represent the thoughts from the instructor on how he viewed the ratings of the two groups.

1. Part One: Getting the Learner Started

The VTE students felt more comfortable in getting started with the course due to initially understanding the course topic better than the resident students. There was a difference of opinion between the groups in the value of course navigation instructions and biography of the instructor. The VTE students felt that having this knowledge was helpful for them. This extra information substituted for the lack of the instructor being physically present. The students understood the instructor and pertinent information on navigation. The hybrid students, on the other hand, felt that this information was not pertinent to them due to the instructor being physically accessible at all times. Whenever

a problem arose, the resident students could schedule visits and talk to the instructor before and after class. Through informal discussions, the hybrid students developed a better relationship with the instructor.

Despite both groups agreeing that the content from this section was meaningfully labeled, they differed again when rating the content in course syllabus and course expectations. “The content was not provided in small paragraphs, the color of the pages was just black and white and nothing in between. They were not labeled well. For example, there was information on grading and assignments but there was not an explanation regarding the course itself. The information was scattered and not placed into modules. Now there are objectives and explanations placed before the start of each module and reading material.”

Since the VTE students probably had taken web-based courses previously, it is more than likely that they have already seen better or worse course sites. They also take a more “we will get through this philosophical attitude.” They understood and accepted that there was a distance gap and the best method of success was to consult with one another when problems arose or if the material was difficult. For the resident students, this was a new experience for them. Learning new subject matter takes time. The vocabulary, theories, and background are difficult concepts to grasp initially. After the first test or assignment, students begin to feel comfortable because they have established some foundation. The resident students also had three other classes to worry about whereas the VTE students only had this one.

2. Part Two: Presentation of the Subject Material

The trend from each group was consistent with what the instructor did not do during the course. For example, the instructor did not use the discussion board and chat room to enhance the Web portion of the course. The instructor incorporated these changes for the next course. He will use the discussion board as a tool to answer frequently asked questions (FAQ) and make available a student self-assessment from each lesson objective where the students are able to discuss objectives to provide a “better opportunity to grasp the material for both sections.” The instructor would like to

see direct and succinct comments ranging from one-quarter of a page to a one-half page relating to the assignment. He believes that the discussion will not only enhance the students' writing skills and thought processes, but also "assist the bashful students in being vocal."

In addition to the discussion board, the instructor has adapted the chat room for students to share their ideas through interaction. He would like to place students into small groups, consisting of a mix of resident and long-distance students to interact and learn from each other. The instructor believes that this mix combines the strengths of the two sections. The resident students are the users and experimenters of the material while the non-resident students are the developers who possess the "real-world knowledge" they can share with their resident peers. "The cooperation between the two groups should equal success."

Incorporating these two methods of web-based instruction will provide the necessary feedback to facilitate a successful online course. The instructor feels that he should receive feedback faster to adjust to the concerns and needs of the students. "These are new methods of instruction and we [instructors] should use these tools to help us pass on the knowledge to the students who can effectively apply it when they return to their jobs."

3. Part Three: Assessing the Subject Material

The students from both sections did not have a mechanism for submitting a critique of the exams to provide feedback to the instructor. Also, there was a lack of feedback given back to the students to review incorrect answers from the exams. In the newly revised course, the instructor has an area for students to comment not only on exams, but also on written and reading assignments. The area is anonymous for students to "entice students to speak freely without retribution." In all, the instructor does not care who gives constructive criticism, but that there is a way to receive the advice.

Finally, the instructor would like to make available for the non-resident students a means for them to receive feedback on the final exams. The resident students have the

luxury of going to the instructor's office to inquire about the their performance and receive additional feedback on single questions. The non-resident students, on the other hand, have no means of physically visiting the instructor. This situation can be more difficult and frustrating for the non-resident students if they desire to obtain feedback. The instructor would also like to afford an area for the students to have access to review questions as they study for the exam.

4. Part Four: Assessing the Usability of the Courseware

The VTE students experienced fewer problems when using their computers to access the web site. This is significant due to the fact that during the course, the original web site was not accessible to due to firewall problems to a few resident and non-resident students. As a result, the instructor hastily constructed a basic web page consisting of assignment folders for each week. The resident students preferred the simple web page while the VTE students continued to access the original web site.

Another reason why the VTE students had better user satisfaction was because of their system. The VTE students used the computer on their desks while the resident students experienced problems such as, "slow downloads and navigations" when using the computers in the different laboratories across campus. The VTE students understood their computer because they were the only individuals using the system. On the other hand, the resident students could not ascertain what the previous student did to the computer before the resident student used it. This has been a problem with the computer laboratories on campus -- each laboratory is different and each computer within the laboratory is different. This arrangement is not conducive to learning because the students divert their attention from the assignment to fixing the computer problem.

Having more experience in taking web-based courses could be another factor in better user satisfaction for the VTE students. By interacting more with the computer than the resident students, the VTE students felt more comfortable in handling "technology problems" associated with long-distance learning.

VII. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Based on the results, one can conclude that the questionnaire is an enabling tool that can be used to measure the effectiveness of instructional design and usability in web-based instruction courses even though the questionnaire was not fully validated by a comprehensive study. The trial application was limited to test an initial set of principles in both areas of study and to establish a foundation for continued research into measuring how usability and instructional design are not independent of each other and why they must be taken into consideration when constructing courses for the Web. The data collected from the hybrid and VTE sections and the post-questionnaire interview with the instructor are consistent with the background information and the initial testing of the principles.

The design for the questionnaire was based on input and feedback from actual users who had experience in web-based instruction, human-computer interface, and usability engineering. Having subject experts participating in the design assisted in the final questionnaire being more effective than the original one constructed for the initial testing. Furthermore, user input provided more validity to the findings and helped to support the principles for web-based education. The rating scale and anchoring system from the QUIS questionnaire was highly instrumental in capturing and categorizing the limited data.

Nevertheless, the questionnaire contained flaws such as baiting statements, which assumed that there should have already been something in place. For example, a statement such as, *Instructional examples were provided* insinuates that there should have been examples of materials, which is to say that having examples of materials is the only correct way to instruct. This is false. As a result, this caused redundancy because questions were repeated but with different phrasing that rendered some questions to be weak.

The major flaw of this study was not receiving data from a purely web-based course. The survey attempted to target this type of class. The resident and non-resident students had the advantage of the instructor being physically present vice virtually present. When there was a problem such as the firewall connectivity, it was remedied quickly through the physical interaction with the instructor. A web-based course class does not have this advantage. However, the error of not obtaining the data demonstrated that communication in web-based education should be simple and direct as possible to avoid errors.

Although there were similarities between our principles and principles from the readings, the major difference between previous studies and this study that warrant some attention is in the attempt to incorporate human-computer interaction and usability into the study. These issues are only mentioned in the readings of instructional design, but they do not go into depth. The objective was to see how web design and the usability of a system could affect the outcome of instructional design: Does the usability of a system affect the educational outcome of the student? In this study, the non-resident students showed a higher user satisfaction than the resident students in computer use and comprehending subject material. However, the percentages of the grades received between the two groups were nearly identical (although grades were not used as a criteria). Nonetheless, the data shows that web-based education can succeed through good instructional design methods and a usable system.

B. RECOMMENDATIONS

Revising and retesting of the questionnaire is necessary in order to improve its effectiveness as a measuring tool for rating web-based education courses. One area that requires improvement is devising a section for users to rate how user-friendly the questionnaire is. Furthermore, weeding out the redundant questions such as questions 72 and 74 will streamline the questionnaire by not only simplifying the phrasing of questions, but also reduce the amount of redundant questions. The sequencing of the questions should be kept the same.

Another aspect missing from the questionnaire were questions pertaining demographics. Including these questions would assist researchers in assessing and identifying different types of groups who take on-line courses. Identifying the different traits should provide more thorough research.

Retesting the questionnaire on purely web-based courses will ultimately prove the effectiveness of the questionnaire. Cooperation between NPS and deployed units would provide a strong foundation for testing. Deployed ships offering training and classes via the Web for the Marines and Sailors, and all oversea bases offering web-based instruction courses could benefit from using this questionnaire to assess their on-line courses, while demonstrating the effectiveness of the questionnaire as a rating mechanism.

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APPENDIX A. INITIAL EVALUATION OF PRINCIPLES

To test the principles and measure the effectiveness of the Instructional Design-Usability questionnaire, an initial evaluation was conducted. The project went through a full iteration of the design-prototype-analyze cycle while demonstrating an understanding of usability engineering, evaluation and design methods, and general knowledge of human-computer interaction.

Six parts were performed: 1. *Problem definition* 2. *Requirements gathering* 3. *Design* 4. *Prototype* 5. *Usability Analysis* and lastly, 6. *Redesign*. Each part is defined and shows the work performed.

A. PROJECT ONE: PROBLEM DEFINITION

This phase consisted of finding and stating a problem in one sentence for clarity. An explanation was given for what activities the system supported, who would use it, the criteria for judging the system, and how would the problem be approached.

1. Problem

The Naval Post Graduate School (NPS) has been actively developing new online courses, but lacks an effective tool to measure the quality instruction in its long distance learning program.

2. Proposal

a. Solution to the Problem

Using instructional design, human computer interface (HCI), and usability principles, a web-based prototype course will be designed that will demonstrate how to create an effective online course.

b. Intended Target Audience

This courseware is web-based and can be accessed from any location. Moreover, the intended target is for instructors and students. The instructors should be

able to put a course online with very little difficulty, and students should learn with ease from the material.

c. Criteria to Evaluate the Project

A formal evaluation will be conducted to ensure the usability of the system. The criteria for judging this site will be how well the instructors and students navigate the site. The instructors will follow a set of instructional design principles to build the course and the students will navigate the course via instructions and take an exam to demonstrate their acquired knowledge. The students will then evaluate the course with a questionnaire that contains questions regarding how the content was presented and the usability of the system. The main consideration for the evaluation is ease of putting a course online and the ease of learning online.

The procedures to evaluate the sessions will be as follows:

Criteria for Instructors

- Time to complete the development of a course online.
- Number of faculty failed to develop a course online.
- Number of times the help section is used.
- Number of times user becomes frustrated and dissatisfied with the course.

Criteria for Students

- Time to complete a course online.
- Number of students who complete the course exam.
- Number of times the help section is used.
- Number of times user becomes frustrated and dissatisfied with the course.

Based on these criteria and the user questionnaire regarding instructional design and usability, the data will be analyzed to correct instructional design and web design problems.

d. Project Design Approach

The design approach throughout the project will be a customer-oriented for students as well as faculty. Since the courseware is already complete, a prototype will be built using various tutorials regarding Internet middleware from students at NPS. After each design phase, informal user input will be immediately solicited about the design. Students from various curricula will evaluate the design by taking the course.

The conceptual design will be created first followed by the semantic design. The physical design will be the third in the sequence of events in developing the course. During this phase, a rapid prototyping tool will be used to develop a prototype that gives the user the look-and-feel of the actual product. Using crayons and pencils, the design will be sketched out for peers to evaluate. After redesigning and revising the design of the course, the course will be placed online for users to take.

B. PROJECT TWO: REQUIREMENTS GATHERING

A needs analysis, user analysis, and task analysis were devised to understand the requirements for the user and the system. A needs analysis establishes the fact that a new system is needed due to external demands by determining basic goals, purposes, and features for the application. The goal, situation of concern, what activities do the designers support, and listing and explaining the features of the system are issues that assist in defining what a user will do with the system.

A user analysis produces a description of the user or user group based on significant characteristics and limitations that might affect the design of the interface.

Information about the work environment, job functions, users' tasks, and characteristics and skills are taken into consideration. Determining how the system will be used, how often, and general computer skill level are examples of defining the user analysis.

A task analysis identifies how users will use the system. A detailed description of tasks, subtasks, and methods that the user and system will share in order to complete a set of tasks are identified through a top-down decomposition. The purpose of this analysis is to avoid duplicating a set of current procedures that the user and computer already perform.

1. Needs Analysis

a. Goal

Develop an interactive interface that allows instructors to develop an online course and students to learn from the course.

b. System Assumptions

- Site is accessible from any location in the world.
- Software runs on a different server from the NPS main server.
- Essay questions will not be graded automatically due to various subjective answers.

c. Instructor Assumptions

1. Interface automatically displays options for construction of course.

- Buttons for displaying where to place course material.
- Instructors begin "clicking" buttons to familiarize themselves and feel comfortable with the product.
- Instructors begin placing material on the site.

2. Instructor does not have any knowledge of developing a course online.

d. Student Assumptions

1. The interface automatically displays options for navigating the site.

- Buttons for navigating the site.

- Students begin "clicking" buttons to familiarize themselves and feel comfortable with the product.
- Students begin learning material from the site.

e. System Features

1. Provide an easy interface for placing material on online for an educational course.
2. Provide an easy interface for learning material from an online course.
3. Allow chat rooms for discussion.
4. Allow email to contact students and instructors.
5. Allow email link to view additional sites and support course material.
6. Allow welcome board for placing course materials.
7. Allow instructor to place buttons that students will need to access information for the course.
8. Allow instructor/student to return to home page when lost/confused.
9. Allow instructor to view course material after placing material in respective places.
10. Allow instructor to modify material for future courses/exams.
11. Allow instructor to form various exams such as, multiple choice, true/false, essay, fill-in-the-blank.
12. Allow instructor to place percentage points on questions.
13. Allow instructor to show incorrect and correct answers.
14. Allow instructor to place time limits on exam.
15. Allow instructor to place time limits on each question.

2. User Analysis (Situation of Concern)

a. User Group

The user group will be instructors and students. These users possess some elementary computer experience such as web browsing. They may be novice/casual users who will not tolerate learning how to navigate a site while attempting to learn a particular subject. Therefore, the design of interface must be so basic that the instructors and students can perform their tasks with ease.

b. Online Community

This application is designed to create an online community of users as the users learn via the web. The users must feel comfortable using this site while they are learning online. The ease of this courseware allows students to asynchronously communicate with each other through chat rooms, email, discussion board, and the welcome site. These features should strengthen the students and instructor into an intellectual community, so they can take/support future courses in long distance learning via the web.

c. Simplicity of the Interface

The users can be expected to have a low frustration level. The interface should be kept as simple as possible. All buttons/options should be easily understood. If the users spend more time trying to navigate the system, they will not be inclined to learn the course material and will not enjoy learning via online.

3. Task Analysis (Activities Supported)

a. Instructor Activities

Primary Task 1: Initiate interface.

- Enter user name.
- Enter user password.
- Go to course panel.

Primary Task 2: Understand the make course panel interface.

- View panel options.
- Identify which buttons perform what action.

Primary Task 3: Develop online course.

- View panel options.
- Select appropriate option.
- Load material.
- Select view material to review material from “student’s point of view.”
- Return to panel options and repeat steps a-c.

Primary Task 4: Allow student to enter course site.

- Enter student user name.
- Enter student password.
- Give student email address, username, and password.

b. Student Activities

Primary Task 1: Initiate interface.

- Enter user name.
- Enter user password.
- Go to course site.

Primary Task 2: Understand the course panel interface.

- View Welcome site.
- View panel options.
- Identify which buttons perform what action.

Primary Task 3: Take online course.

- Select appropriate button to view course material.
- Read course material and perform required work.

- Navigate to next course folder.

Primary Task 4: Close interface.

- Student selects file menu.
- Student selects Exit.

C. PROJECT THREE: SYSTEM DESIGN

This portion of the project is the most complex due to unlimited ideas and possibilities when discussing design issues. Carroll and Rosson (1985) explain that design, as a *process* is one of the least understood development activities-for user interfaces or in any domain. It may be due to creativity and individuality. Requirements become lost and neglected for the sake of creativity and individuality. Due to this complexity, constant evaluation of design is necessary in order to develop a good product. Conceptual design, detailed design, and an early analysis assist in maintaining design as a process. Conceptual design is a higher level of design and pertains to analyzing objects, attributes of objects, and the relationships between objects, actions on objects, actions on attributes, and actions on relationships.

Detailed design or visual design entails activities such as, wording of messages labels and menu choices. How will these object appear on the screen and navigation from screen to screen are considerations that designers must take into account. A simple and effective method is using paper, pencil, and crayons to sketch the screens that are needed for the design. Based on the functionality outlined in the task analysis and the function points in the conceptual design, designers should determine how this functionality will be addressed via menus, buttons, dialogue boxes and everything else that will be used for the actual version of the finished product.

When conducting an early analysis, designers should show their sketches to as many reviewers as time permits who are unfamiliar with the project. The designers should walk them through the designs and tasks to obtain some initial feedback as to the efficacy of the design. Writing down the comments from the given constructive criticism

helps designers to see keep their design according to the specified requirements of the user.

1. Conceptual Design

NOTE: Designing for this was difficult because the courseware for the online course was already created. This was a framework that the researchers could not change. Taking this constraint into account, the focus of this phase was on incorporating the instructional design and usability principles and how they could be used as a measuring tool to evaluate how effective the content of information is for the student.

a. Objects

Student Interface Window Buttons

- Announcements
- Course and Information
- Staff Information
- Course Documents
- Assignments
- Communication
- External Links
- Student Tools
- Resources
- Search
- Logout

Instructor Interface Window Buttons

The instructors Interface will have the same features as the students but they will also have a *control panel button* that allows instructors to build a course.

b. Object Attributes

The students and professors will have the option of deciding their type of

buttons, colors, and shape of the buttons.

Student attributes

- Username
- Password
- Registered courses
- Age
- First Name
- Last name

Faculty Attributes

- Password
- Registered courses
- Age
- First Name
- Last name
- Courses to be taught

Message Attributes

- From attribute
- To attribute
- Subject attribute

Course Attributes

- Course number with departmental code
- Course title
- Description of course
- Goals of course

- Prerequisites for course
- Professor of Course

Assignment Attributes

- Course Name
- Due Date
- Guidelines
- Assignment Number

c. Relationship between Objects

- The interface window contains the welcome board
- User begins navigating the course via the options and instructors comments.
- Only instructors have access to the control panel where they will have numerous options to build the course.
- Each student will have his/her username and password to access the site.
- Students and instructors can post messages for assignments.
- Instructor can post readings, assignments, and exams for students.
- Students can submit assignments electronically prior to due date.
- Course will have one or more courses.

d. Action Object Attributes

- Users are able to navigate the site.
- Users are able to change button colors
- Users are able to change shape of buttons to square or circle
- Users are able to navigate the site and return to Welcome Page
- Users are able to enter a chat room
- Express ideas, thoughts, and problems about assignments
- Leave the chat room

e. Actions on Relationships

- Various options can be disabled for the course if the instructor deems necessary.

f. Project Concessions

- The chat rooms and the courses will not be implemented.
- Material from one course as a design will be shown.
- Concentration on the instructional design principles will be an emphasis since the courseware has already been created.

2. Visual Design

Note: the sketches for this portion will not be incorporated into the thesis because the design could not be transferred electronically.

After entering the username and password, the *announcement page* displays any news the student needs for the course. Directions for the course may also be placed in the announcement page. The course material appears in the course information folder. The student can then proceed to navigate the course by choosing various options.

A tutorial appears after the student clicks on the course information folder allowing the student to read and study the material.

The large magnitude of symbol selection and icon placement possibilities makes it difficult to illustrate these via sketches. Those developed by the low fidelity tests subjects are included in the Early Analysis.

3. Early Analysis

Note: For simplicity, the evaluator's Task List and one Low Fidelity Test are been submitted as examples.

Four test subjects were individually asked to evaluate the content of material and navigability of the course. Each subject was asked to read and then explain the content of

the material. From these explanations and more suggestions from the participants, improved principles and a measuring tool to build an effective course were derived.

Summary of analysis

- The content was presented in "small understandable paragraphs."
- The phrasing and wording of folders such as, guidelines and organizing tasks was a big problem.
- Participants commented regularly on layout, design of product, and its usability rather than commenting on the content.
- The design of the system does not affect how experienced or inexperienced users use the system and learn from the material.
- From evaluator's perspective: The instruction design principles need to be improved and more emphasis on creating a better checklist for designing a course needs to be implemented.

These results will be considered carefully and incorporated into an improved design before proceeding with the prototype implementation.

Project 3 Task List

Evaluator's copy of the task list

Reference p. 50 of Class Notes, Develop the Experiment

Question: How do we demonstrate that the instructional design principles and usability principles enhance web-based instruction?

Questionnaire, analysis of errors:

1. Student understands the Welcome Page instructions. Benchmark: Student does not feel "overwhelmed" by the content. (Information is presented in small chunks).

    a. Read instructions
    b. Explain instructions.

2. Student is comfortable with course instructions. Benchmark: Student navigates to Course Documents. Student does not feel "overloaded" by the content.

    a. Read course objectives
    b. Read syllabus (class schedule)
    c. Read negotiating guidelines
    d. Explain a – c.

3. Student comprehends presented material. Benchmark: Student reads material, takes a quiz, and passes quiz. Student does not feel "overloaded" by the content.

    a. Read material.
    b. Explain material

Project 3: Example of Low Fidelity Test Evaluation
Tester: Erich Stefanyshyn
Subject: Male, USMC, Captain, 31 years

Overview: The evaluation lasted 25 minutes. During this time, the subject was given various outlays of the interface and asked to review the content of material on the "screen."

Subject's first impressions:

Task 1: Student did not feel "overwhelmed" by the material. He thought that it was organized and could understand the intent of the course. However, He wanted to see the message once. He thought that a "1st time for visitors" message should be placed to avoid redundancy and boggle of material.

Task 2: Student did not feel "overloaded" by the material. However, the content could be better explained. For example, when meeting, the instructor needs to explain that the meeting will be "meeting online asynchronously" vice "meeting asynchronously." Another good recommendation is meeting synchronously "via chat room and discussion boards at your (groups convenience)." Furthermore, there should be some directions on where to navigate next from the course objectives folder to the class schedule folders. It helps to "channel the transition from folder to folder."

Task 3: 1st Part: The material in the explanation folder was not overwhelming, but it was not organized as well as the previous Task 1 and 2. For example, there should be check boxes assigned to the instructions to remind users (inexperienced and experienced) where to go and what to do. When they finish, they can check the boxes. The objectives and assignments should be simpler. Also, place time limits on the reading assignments and keep a, "instant review sheet next to the assignment for venting purposes." For example, if an assignment lasts one hour and the student takes 2 hours to complete the reading, the student should go back to his checklist and be able to let the instructor know that there the assignment was "overload." Place a message on top for students to critique honestly to let them know that this is their site and education.

2nd Part: This should be the "last hyperlink because it takes the most time to do." Content is sufficient, but there is too many paragraphs. Incorporate more "bullets" for both users. For "inexperienced, to see ideas and experienced to go directly to the material." Also "hyperlink the bullets for the paragraphs". Overall, the buttons for navigating are confusing. For instance, *Assignment button* = test and should be a daily task like *course documents.* Also, divide the lessons into day/time periods. For example, Week1: day 1, 1 hour limit, day 2, 1 hour limit, etc.

Subject's Opinion: Subject noted the need to change some of the buttons for better clarification. Subject stressed that the material needs to be as clear and concise as possible to avoid confusing the student. Subject would also like to see the live program.

D. PROJECT FOUR: PROTOTYPE

Based on the results from the design in Phase 3, a prototype is built for more testing and evaluation. It involves production of at least one early version of the system that displays the important features of the system in operation. Prototyping is very beneficial to a project because it involves user participation and lets developers observe how the users interact with the system. In short, like a car, the user is "taking the system for a spin" (Hix & Hartson, 1993).

A prototype for the web-based evaluation was constructed using the school's courseware. A course based on Internet Middleware was put online. The lesson involved Web/Site Management Tools for constructing Web pages. It was built according to the measuring tool that was made following in Project 3 and issued in project 5.

E. PROJECT FIVE: USABILITY ANALYSIS

A usability analysis allows users and developers to see how well the design and the prototype were constructed, and measure its effectiveness and usability.

Planning well for a usability analysis is imperative for its success. The testers should ensure that a set of tasks have been planned for the users. The tasks should measure what the system is supposed to be used for. Users who will interact with the

system should be chosen as subjects. The more subjects tested, the more feedback can be garnished for analysis to assess the usability of the system.

At this stage, data collection is more formal and contains both qualitative and quantitative elements. The same questions asked in the phase three are asked more in depth. Evaluators are looking for where the system did not meet user expectations. E*fficiency* is one method of evaluation. How optimal did the users perform the tasks? How long did it take to complete the tasks? Could these tasks been made any easier? Were there delays in the system (where the user spent time thinking about what to do next)? How can these be removed or minimized?

Errors are also analyzed. Do users make errors? If so, can they be engineered out of the system? If not, has the design been adequately accounted for them by being recoverable and informative messages placed to assist the user? What errors were made and were they critical?

Learnability/Memorability is taken into account by evaluating how easy the system was easy to use. Will users need help and training? Most importantly, how well does the error rate drop as the user become more familiar with the system? If not, the problems need to be identified and corrected.

Finally, *user satisfaction* with the system is also evaluated. Would they like to see it on-line for real usage? What changes did they suggest to make? Usually the user's suggestions bring out ideas that were not thought about previously. Finally, the measurement of user satisfaction is when the user does comment negatively about the system and does not say anything while using the system. This demonstrates that the user is heavily engaged and the system is easy to use.

1. Results from the Usability Analysis

The Test Tasks outlined in Appendices 1 and 2 were designed to observe and record how the users interacted with the presented material. Some of the interactions involved mouse and button manipulation based on instructions within the content. Appendix 3 demonstrates the post course questionnaire that the users evaluated after

taking the course. When users did not know what to mark, they were referred to the Task List assist them. For instance, the first checklist, “Are the students welcomed properly,” one subject did not know what to put, and when shown where the welcome phrase was located, he was ready to mark 5. But he was told to judge the guideline when he was at that page during the course session. He changed his opinion to 3 because “he did see it but he did not feel as welcomed because it did not stand out and grab him.” Finally, at the beginning of the each interview, the importance of comments and criticism of the interviewee was highly expressed and encouraged. Throughout the test and interview, the evaluators constantly encouraged the users to comment and think loudly.

Also contained, as appendices are the consent, minimal risk, privacy act statement, and participant demographics forms.

a. Efficiency

Were the users able to navigate based on the instructor’s comments?

The subjects could navigate on the instructor’s comments. After reading the instructions, the students spent very little time to find the buttons and utilize the system. A typical question during the process was, “Is this the button to press?” or “Do I go here?” After clicking on the button(s), the subjects immediately understood how the system worked and could concentrate on the material.

To better the course, all subjects preferred that a hyperlink be placed next to the final instruction instead of having to search for the button. Otherwise, the content was straightforward.

Did the computer interface interrupt the course content?

As long as they could follow the course, the subjects felt that the system was easy to use, and that they could concentrate on the material. Since none of the subjects used *Help*, we saw that as a good indication that they were concentrating on the material vice fighting the system.

Did the users feel that any tasks could have been easier to perform?

During the presentation of the material, as the subjects read and clicked on various web sites, they would have liked to have seen the reading objectives, assignments, and review questions on the reading pages in addition to being in the *Course Syllabus.*

The additional links within the material should be placed after the paragraph because the readers preferred to read the material first and then have the "option of clicking the link for more information." One subject wondered about the use of links when she said, "this could go on forever, when do I stop?" Placing the links after the paragraph would structure the material better and let the students read the main content and then assists students who are interested to visit other sites. The uninterested students could continue to the next paragraph of information. One subject, for example, did not click on any hyperlinks because he did not know where he would go and also did not know if he should have clicked on them.

Overall, the learning material was overwhelming due to the lack of structure. For instance, "The web sites had a lot of information, and at what point do I stop [navigating]?" The content should be organized better and an explanation the websites should be provided to the students. This way, students will know what to expect from the site and when they should stop.

b. Errors

Could context errors be engineered out of the system?

All subjects complained about word misspellings. "It distracts me from the reading. Now I have to start all over again. I don't like typos in my textbooks nor do I like them on my computer."

Bolding was another issue the subjects mentioned when they navigated the site. The wording in each folder was identical. Nothing "stuck out and grabbed my

attention." At the *Welcome Page*, although there was a "welcome comment," it was hard to distinguish because it was in plain text and meshed in with the other material. As a result, two of the subjects "did not feel welcomed."

The biggest complaint involving errors was the lack of indentations in all folders (especially the *Course Guidelines* folder). We failed to indent the material and it made the content difficult to read and understand.

Did the system account for errors?

No, this where the system falls short of expectations and the instructor should compensate for them. The system itself did not allow for indentation, spelling check, and bolding. When we tabbed, the cursor went to another location on the screen. Even though we could have used the space bar to compensate, we did not because it was time consuming. Nevertheless, by not investing the extra time, and effort caused problems for our users. This lack of system functionality causes hardship on the instructor (spending time) and students (dealing with the problems).

What critical incidents could be identified?

One potential (and greatest) error associated with the course is content instructions and linking to other websites. If the instructions are not clear and the web sites are not explained, students could spend endless hours and wonder when to stop. They could become frustrated with the system and the course, and eventually, lose interest with the online education. "The web site should be used to explain and enhance the material." This avoids information overload and makes learning easy.

c. Learnability/Memorability

Was the system easy to learn?

The system was easy to learn. The users did not have complaints about the product. The wording of the button features was different than what they expected. Even

though there was not an exam, the users associated the Assessment folder for assignments rather than for exams.

Did the system confuse the student?

Like easy to learn, the system did not confuse the subjects. In the beginning of the course, they adjusted to the interface by clicking on various buttons. Thereafter, they concentrated on the material.

Did the content confuse the student?

The students were confused in the Course Guidelines, Syllabus, and Course Documents folders. The confusion was due to the lack of organization and the already mentioned errors. The course subject was pleasing, but the content needed to be structured better.

d. Satisfaction

Were the users satisfied with the system?

The users enjoyed the system. They did not go to *Help* for assistance. When they became misguided, they clicked back until they found a page they were most comfortable and familiar with and restarted.

Were the users required to use "Help?"

The users did not use this feature.

Were the users satisfied with the course content?

Overall, the users did like the content. Some of the subjects were already familiar with the information and skipped to other topics. They also enjoyed surfing the

websites (Web Monkey was the most used). As for the material being presented in small chunks, most of the users felt that the bits of information was sufficient. However, there should be a main textbook for the course. Furthermore, all subjects noted that the material was for students who are interested in Internet middleware and/or for higher-level students. Finally, a glossary page should be added or terms should be listed with the assignments so the student does not feel "belittled."

Would they like to see it online for real usage?

The subjects did enjoy the course and believe that they could learn from it if it is placed online as an actual course. They would like to see the changes.

2. Analysis

For web-based instruction, system usability is dependent on good instructional design as instructional design is dependent on a good reliable system. Even though the computer system is running perfectly, the user may become dissatisfied with an online course because the content is not organized and coherent. If students spend more time wrestling with the presentation of content rather than the content itself, they begin to divert their time from the content to adjust to the presentation. As a result, students spend more than the usual amount of required time on a course and may become frustrated with long distance education. This defeats the purpose of long distance education that allows students to take the course asynchronously for a short amount of time.

The instructors are another aspect to consider because they have to put the course online. If the instructors do not have the proper guidance and tools to transfer a traditional course into a web-based course, they also become frustrated with the online education process, because they have invested time into their courses to be successful. The courseware may function properly, but if they do not know how to put the course online, then it is better to have no online course than a bad online course.

Instructors also need to compensate for a product's weakness through instructional design. Although the intent of this research is not to judge the product used, but show that constraints of systems do affect how a course is put online. Sometimes the constraints affect the intended user, which in this case, is the student. Instructors need to put on their creative hats to compensate for the constraints by adding audio and/or text related photos. By the same token, by placing the course contents on file and having students link to the file from the courseware site may compensate for the lack of bold, indents, and reduce typos. However, the increased linking can also hinder learning due to

more navigating which increases the chance of becoming "lost", and the file document may not be presented as well via the system.

The guideline checklist needs to be reworded so that the instructor or students do not just "check the block." For instance, guideline 11 says, *a syllabus (class schedule) is in place*. It should also be followed by *how clear is the syllabus* and *is it presented in small chunks*? After all, the intent of the checklist is to assist instructors to put an effective course online, and for students to recognize what basic ingredients are necessary to constitute a good online course. A heuristics evaluation using better benchmarks to measure the users' behaviors.

The course content needs to be revised. More indentation, bold, and hyperlinks should be placed in better strategic places.

Finally, the broad range of participants from various curricula provided a very good insight of how people view the course. The student from the Information Technology department was more interested in the buttons whereas the student from System Management cared more about presentation (fonts, indents). For future considerations, more testing involving various backgrounds of students to determine how effective a course could be tailored according to an improved checklist.

Project 5 Evaluator's Task List

Reference p. 50 of Class Notes, Develop the Experiment

Question: How do we demonstrate that the Instructional Design Principles enhance web-based instruction? Does the usability (computer interface) affect/distract the user from the content? How effective is the questionnaire as a measuring tool for web-based instruction?

Note: Due to time constraints, we will not test benchmark four. It will remain in the benchmarks for future consideration.

Benchmark 1: Does the student understand the instructions on the Welcome Page? Student does not feel "overwhelmed" by the content. (Information is presented in small chunks).

Ask the subject to read and explain the content.

Benchmark 2: Is the student comfortable with course instructions? Student navigates to Course Information Documents. Student does not feel "overloaded" by the content.

a. Read course objectives
b. Read syllabus (class schedule)
c. Read course guidelines
d. Explain a – c.

Benchmark 3: Is the student comfortable with course instructions?

Student navigates to Course Documents. Student does not feel "overloaded" by the content.

a. Read course objectives
b. Explain material

Benchmark 4: Does the student comprehend presented material?

Student reads material, takes a quiz, and passes quiz. Student does not feel "overloaded" by the content.

a. Read material.
b. Explain material

Project 5 Participant's Task List
Reference p. 50 of Class Notes, Develop the Experiment

You are testing the course material. The expected time is 30 minutes. During this time, you may read and think aloud. When you are finished with the mini-course, we will ask questions pertaining to the material. This part will last no longer than 20 minutes. *Whenever the interface distracts you from the content, please say what feature distracts you and why*.

Instructions for the course

1. Read the material on the "Welcome" Page.

2. Read the material on the "Course Information" Page.

3. Read the material in the "Course Documents" page.

4. Explain all sections.

5. Using the questionnaire, rate the sections and the material.

Project 5 Consent Form

1. **Introduction.** You are invited to participate in a study of web-based instruction. With information gathered from you and other participants, we hope to discover insight on how Instructional Design principles and Human Computer Interface/Usability principles affect online learning. We ask you to read and sign this form indicating that you agree to be in the study. Please ask any questions you may have before signing.

2. **Background Information.** The Naval Postgraduate School Distance learning is conducting this study.

3. **Procedures.** If you agree to participate in this study, the researcher will explain the tasks in detail. There will be two sessions: a) 30 minute mini-course at a web site and 2) a post interview discussing the content of the course and any distractions the system caused to the subject.

4. **Risks and Benefits.** This research involves no risks or discomforts. The benefits to the participants are understanding web-based instruction and contributing to current research in web-based instruction.

5. **Compensation.** No tangible reward will be given. A copy of the results will be available to you at the conclusion of the experiment.

6. **Confidentiality.** The records of this study will be kept confidential. No information will be publicly accessible which will possibly identify you as a participant.

7. **Voluntary Nature of the Study.** If you agree to participate, you are free to withdraw from the study at any time without prejudice. You will be provided a copy of this form for your records.

8. **Points of Contact.** If you have any further questions or comments after the completion of the study, you may contact the research supervisors, Capt Erich I Stefanyshyn or 1st Lt Mehmet Sezgin at (408) 656 – 4071 (Email: eistefan@.nps.navy.mil or msezgin@nps.navy.mil).

9. **Statement of Consent.** I have read the above information. I have asked all question and have had my questions answered. I agree to participate in this study.

---	---
Participant's Signature	Date
---	---
Researcher's Signature	Date
---	---
Researcher's Signature	Date

Project 5 MINIMAL RISK CONSENT STATEMENT
NAVAL POSTGRADUATE SCHOOL, MONTEREY, CA 93943

Subj: VOLUNTARY CONSENT TO BE A RESEARCH PARTICIPANT IN: WEB-BASED INSTRUCTION EXPERIMENT

1. I have read, understand and been provided "Information for Participants" that provides the details of the below acknowledgements.

2. I understand that this project involves research. An explanation of the purposes of the research, a description of procedures to be used, identification of experimental procedures, and the extended duration of my participation have been provided to me.

3. I understand that this project does not involve more than minimal risk. I have been informed of any reasonably foreseeable risks or discomforts to me.

4. I have been informed of any benefits to me or to others that may reasonably be expected from the research.

5. I have signed a statement describing the extent to which confidentiality of records identifying me will be maintained.

6. I have been informed that since the risks are minimal any injury I suffer while participating in the experiment will be at my own risk and that I accept full responsibility for my own medical treatment.

7. I understand that my participation in this project is voluntary. Refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled. I also understand that I may discontinue participation at any time without penalty or loss of benefits to which I am otherwise entitled.

8. I understand that the individual to contact should I need answers to pertinent questions about the research are Rudy Darken, Ph.D. and Anthony Ciavarelli, Ph.D., Principal Investigators, and about my rights as a research subject or concerning a research related injury. A full and responsive discussion of the elements of this project and my consent has taken place.

Signature of Principal Investigator(s) Date

Signature of Volunteer Date

Signature of Witness Date

Project 5 PRIVACY ACT STATEMENT

1. Authority: Naval Post Graduate School, Monterey, CA 93940, Naval Instruction

2. Purpose: Web-based instruction, instructional design principles and Human Computer Interface (HCI)/Usability principles will be studied to enhance knowledge, and/or improve long-distance education programs at the Naval Postgraduate School.

3. Use: Information on web-based instruction will be used for analysis by the Departments of the Navy and Defense, and other U.S. Government agencies, provided this use is compatible with the purpose for which the information was collected. Use of the information may be granted to legitimate non-government agencies or individuals by the Naval Postgraduate School in accordance with the provisions of the Freedom of Information Act.

4. Disclosure/Confidentiality:

    a. I have been assured that my privacy will be safeguarded. I will be assigned a control or code number, which thereafter will be the only identifying entry on any of the research records. The Principal Investigator will maintain the cross-reference between name and control number. It will be decoded only when beneficial to me or if some circumstances, which are not apparent at this time, would make it clear that decoding would enhance the value of the research data. In all cases, the provisions of the Privacy Act Statement will be honored.

    b. I understand that a record of the information contained in this Consent Statement or derived from the experiment described herein will be retained permanently at the Naval Postgraduate School or by higher authority. I voluntarily agree to its disclosure to agencies or individuals indicated in paragraph 3 and I have been informed that failure to agree to such disclosure may negate the purpose for which the experiment was conducted.

    c. I also understand that disclosure of the requested information, including my Social Security Number, is voluntary.

_____

Signature of Volunteer, Print Name, Grade/Rank, DOB, SSN, Date

_____

Signature of Witness **Date**

Project 5 PARTICIPANT DEMOGRAPHICS

Participant ID (assigned by tester): _____

Circle the best choice.

Sex: M F

Age: under 18 20-25 25-30 30-35 over 30

Education level: HS diploma GED BS/BA MS PhD

Computer Experience: None Novice Intermediate Advanced

APPENDIX B: INSTRUCTIONAL DESIGN-USABILITY QUESTIONNAIRE

PART 1: Getting the Learner Started

This section provides a *"big picture view"* of the course. It assists students by providing a course description, prerequisites for the course, course objectives and goals, navigation of the web site, and instructor biography, a course syllabus (of chapters to read, homework assignments, tests, etc), and course expectations (of the instructor and student).

Before continuing with the course, students should be able to understand course objectives, syllabus, and expectations, and how to access the course lessons.

INSTRUCTIONS

Please circle the numbers, which most appropriately reflect your impressions about this course.

Not Applicable = NA.

Instructional Quality

1.1 Course Objectives

1.1.1	Course goals defined	confusing clear 1 2 3 4 5 6 7 8 9	NA
1.1.2	Brief course description	confusing clear 1 2 3 4 5 6 7 8 9	NA
1.1.3	Course prerequisites	confusing clear 1 2 3 4 5 6 7 8 9	NA
1.1.4	Students given instructions/orientation on course navigation	unhelpful helpful 1 2 3 4 5 6 7 8 9	NA
1.1.5	Biography of instructor	unhelpful helpful 1 2 3 4 5 6 7 8 9	NA

1.2 Course Syllabus/Class Schedule

1.2.1	Class schedule (when class meets)	confusing clear 1 2 3 4 5 6 7 8 9	NA
1.2.2	Class agenda (amount of reading per week, required assignments due, exam dates)	confusing clear 1 2 3 4 5 6 7 8 9	NA

1.3 Course Expectations

1.3.1	Role of the instructor was defined	confusing clear 1 2 3 4 5 6 7 8 9 NA
1.3.2	Students' responsibilities	confusing clear 1 2 3 4 5 6 7 8 9 NA
1.3.3	Grading criteria and procedure	confusing clear 1 2 3 4 5 6 7 8 9 NA

Web Design

1.4 Course Objectives

1.4.1	Content from course objectives (i.e. font, bold, italics, underlines, misspellings, etc)	hard to read easy to read 1 2 3 4 5 6 7 8 9 NA
1.4.2	Content provided in understandable paragraphs	inadequate adequate 1 2 3 4 5 6 7 8 9 NA
1.4.3	Content is meaningfully labeled	illogical logical 1 2 3 4 5 6 7 8 9 NA

1.5 Course Syllabus/Class Schedule

1.5.1	Content (i.e. font, bold, italics, underlines, misspellings, etc)	hard to read easy to read 1 2 3 4 5 6 7 8 9 NA
1.5.2	Content provided in understandable paragraphs	inadequate adequate 1 2 3 4 5 6 7 8 9 NA
1.5.3	Content is meaningfully labeled	illogical logical 1 2 3 4 5 6 7 8 9 NA

1.6 Course Expectations

1.6.1	Content (i.e. font, bold, italics, underlines, misspellings, etc)	hard to read easy to read 1 2 3 4 5 6 7 8 9 NA

1.6.2 Content provided in understandable paragraphs inadequate adequate
1 2 3 4 5 6 7 8 9 NA

1.6.3 Content is meaningfully labeled illogical logical
1 2 3 4 5 6 7 8 9 NA

Please write your comments about the *Getting the Learner Started* section here:
_____
_____
_____
_____
_____

PART 2: Presenting the Subject Material

This section evaluates the actual lesson/module. This is where the actual learning begins. The instructor may have organized the material into weekly folders, topic folders, and/or a hyperlink for the week for the student to view or download.

In this area, the number of options for delivering a lesson ranges from purchasing a textbook for the course, additional reading(s) via the web, problems, exercises, discussions via chat rooms and/or discussion boards, written assignments (summaries), and/or extra web-links to enhance the lesson(s).

INSTRUCTIONS

Please circle the numbers, which most appropriately reflect your impressions about this course.

Not Applicable = NA.

Instructional Quality

2.1 Purpose of the Course

2.1.1 The purpose of each module/section was adequately defined never always
1 2 3 4 5 6 7 8 9 NA

2.1.2 Learning objectives for each component of the course were adequately defined never always
1 2 3 4 5 6 7 8 9 NA

2.1.3 Weekly/module folders are in logical order never always
1 2 3 4 5 6 7 8 9 NA

2.2 Instructor's Participation

2.2.1 Students were encouraged to collaborate never always
1 2 3 4 5 6 7 8 9 NA

2.2.2 Instructor gave learning guidance
never always
1 2 3 4 5 6 7 8 9 NA

2.2.3 Learning guidance was adequate
never always
1 2 3 4 5 6 7 8 9 NA

2.3.4 The instructor responded to students' questions/concerns regarding material
never always
1 2 3 4 5 6 7 8 9 NA

2.3.5 Instructor's participation met student expectations
never always
1 2 3 4 5 6 7 8 9 NA

2.3 Presentation of Subject Material

2.3.1 Instructional material was presented at proper level
difficult easy
1 2 3 4 5 6 7 8 9 NA

2.3.2 Instructional explanations of material
confusing clear
1 2 3 4 5 6 7 8 9 NA

2.3.3 Instructional explanations included useful illustrative examples (pictures, graphs, diagrams, etc)
never always
1 2 3 4 5 6 7 8 9 NA

2.3.4 Assigned reading related to course objectives
never always
1 2 3 4 5 6 7 8 9 NA

2.3.5 Instructional content relevant to learning objectives
never always
1 2 3 4 5 6 7 8 9 NA

2.3.6 Instructional content in correct sequence
never always
1 2 3 4 5 6 7 8 9 NA

2.3.7 Supplementary web sites provided to enhance learning
never always
1 2 3 4 5 6 7 8 9 NA

2.3.8 Subject material was highly interactive
never always
1 2 3 4 5 6 7 8 9 NA

2.3.8.1 Interaction of subject material useful
never always
1 2 3 4 5 6 7 8 9 NA

2.3.9 Content engaged the student in active learning tasks
never always
1 2 3 4 5 6 7 8 9 NA

2.4 Assignments for Subject Material

2.4.1 Assignment helped achieve learning objectives
never always
1 2 3 4 5 6 7 8 9 NA

2.4.2 Review of material was provided never always
1 2 3 4 5 6 7 8 9 NA

2.4.3 Instructional practice examples were provided never always
1 2 3 4 5 6 7 8 9 NA

2.4.4 Discussion board was used during the course never always
1 2 3 4 5 6 7 8 9 NA

2.4.4.1 Discussion board useful never always
1 2 3 4 5 6 7 8 9 NA

2.4.5 Chat rooms were used during the course never always
1 2 3 4 5 6 7 8 9 NA

2.4.4.1 Chat rooms useful never always
1 2 3 4 5 6 7 8 9 NA

2.4.4 Written assignments (term papers, one-page summaries, etc) were included in each assignment never always
1 2 3 4 5 6 7 8 9 NA

2.5 Feedback Section for Students

2.5.1 Feedback section on lesson available for students never always
1 2 3 4 5 6 7 8 9 NA

2.5.2 Feedback section on lesson useful never always
1 2 3 4 5 6 7 8 9 NA

Web Design

2.6 Subject material content
(i.e. font, bold, italics, underlines, misspellings, etc) hard to read easy to read
1 2 3 4 5 6 7 8 9 NA

2.7 Subject material content provided in understandable paragraphs inadequate adequate
1 2 3 4 5 6 7 8 9 NA

2.8 Content is meaningfully labeled illogical logical
1 2 3 4 5 6 7 8 9 NA

Please write your comments about the Presentation of the Subject Material here:

_____
_____
_____

PART 3: Assessing the Subject Material

This section rates the exams, projects, term papers, etc. of the subject material.

INSTRUCTIONS

Please circle the numbers, which most appropriately reflect your impressions about this course.

Not Applicable = NA.

Instructional Quality

3.1	Exam questions relevant to learning objectives	never always 1 2 3 4 5 6 7 8 9	NA
3.2	Exam questions presented at proper level	never always 1 2 3 4 5 6 7 8 9	NA
3.3	Exam questions were understandable	never always 1 2 3 4 5 6 7 8 9	NA
3.4	Exam had a reasonable time limit	never always 1 2 3 4 5 6 7 8 9	NA
3.5	Exam provided feedback and review when questions answered incorrectly	never always 1 2 3 4 5 6 7 8 9	NA
3.6	Instructional content provided adequate exam preparation	never always 1 2 3 4 5 6 7 8 9	NA
3.7	Student critique section of exam provided	never always 1 2 3 4 5 6 7 8 9	NA
3.8	Assessments other than exams (papers, projects, assignments, etc) were used in this course	never always 1 2 3 4 5 6 7 8 9	NA
3.8.1	Assessments relevant to learning objectives	never always 1 2 3 4 5 6 7 8 9	NA

Web Design

3.9	Exam content (i.e. font, bold, italics, underlines, misspellings, etc)	hard to read easy to read 1 2 3 4 5 6 7 8 9	NA
3.10	Exam content provided in understandable paragraphs	inadequate adequate 1 2 3 4 5 6 7 8 9	NA

3.11	Content is meaningfully labeled	illogical logical 1 2 3 4 5 6 7 8 9	NA

Please write your comments about the Assessing of Subject Material section here:

_____
_____
_____
_____
_____

PART 4: Assessing the Usability of the Courseware

Courseware is the software program that is used to deliver the course (Blackboard, Cnet, Courseware, etc) online. If the courseware does not function properly (interface, buttons, link time, navigation, runs slow), it may be difficult for the student to concentrate on the material.

Input from students on how the courseware functions, is vital for the success of web-based instruction because if students cannot use it, then the courseware hindered the learning process.

INSTRUCTIONS

Please circle the numbers, which most appropriately reflect your impressions about this course.

Not Applicable = NA.

4.1	Student critique provided for courseware	never always 1 2 3 4 5 6 7 8 9	NA
4.2	Courseware was easy to learn	never always 1 2 3 4 5 6 7 8 9	NA
4.3	Courseware was easy to use (after learning it, did you struggle with it for the remainder of the course)	never always 1 2 3 4 5 6 7 8 9	NA
4.4	Course site was accessible (connectivity, firewall)	never always 1 2 3 4 5 6 7 8 9	NA
4.5	Course site required to much navigation to view actual content (clicking until site reached)	never always 1 2 3 4 5 6 7 8 9	NA
4.6	Were there difficulties in navigating from page to page	never always 1 2 3 4 5 6 7 8 9	NA

4.7	Were there difficulties in navigating between lessons	never always 1 2 3 4 5 6 7 8 9	NA
4.8	Were there difficulties in navigating from course page to web links and back to course page	never always 1 2 3 4 5 6 7 8 9	NA
4.9	Were there difficulties in paging from top of page to bottom of page	never always 1 2 3 4 5 6 7 8 9	NA
4.10	Were there difficulties in paging from bottom of page to top of page	never always 1 2 3 4 5 6 7 8 9	NA
4.11	Were there difficulties in finding the "home" page	never always 1 2 3 4 5 6 7 8 9	NA
4.12	Were there difficulties in finding the desired web page (location)	never always 1 2 3 4 5 6 7 8 9	NA
4.13	Speed of Courseware was adequate (waiting a long time to go to next site and for downloads)	never always 1 2 3 4 5 6 7 8 9	NA

Please write your comments about Assessing the Usability of the Courseware here:

_____
_____
_____
_____
_____
_____

APPENDIX C: QUESTIONNAIRE FOR USER INTERACTION SATISFACTION

The following scanned document is a more detailed explanation of the The Questionnaire for User Interaction Satisfaction (QUIS) 7.0 developed by the University of Maryland to assess the usability of computers/systems as explained in Chapter IV. The explanation begins on the following page due to the format of the scan.

The University of Maryland granted permission to reprint this document. For more information regarding QUIS 7.0 can be obtained by visiting www.otc.umd.edu/Gateway/Summer98/transfer.html or writing the Office of Technology Liaison at otl.umail.umd.edu.

About the QUIS™, version 7.0

The Questionnaire for User Interaction Satisfaction (QUIS™) is a tool developed by a multi-disciplinary team of researchers in the Human-Computer Interaction Lab (HCIL) at the University of Maryland at College Park. The QUIS™ was designed to assess users' subjective satisfaction with specific aspects of the human-computer interface. The QUIS™ team successfully addressed the reliability and validity problems found in other satisfaction measures, creating a measure that is highly reliable across many types of interfaces.

QUIS™ 7.0 is the first update of the QUIS™ content since 1989. It contains a demographic questionnaire, a measure of overall system satisfaction along six scales, and hierarchically organized measures of eleven specific interface factors (screen factors, terminology and system feedback, learning factors, system capabilities, technical manuals, on-line tutorials, multimedia, teleconferencing, and software installation). Each area measures the users' overall satisfaction with that facet of the interface, as well as the factors that make up that facet, on a 9-point scale. The questionnaire is configurable according to the needs of each interface analysis by including only the sections that are of interest to the user.

PART 1: System Experience

This section measures the user's experience with the system or systems being tested. Both length of experience and frequency of use are measured.

PART 2: Past Experience

This section gauges the user's experiences with computer systems in general.

PART 3: Overall User Reactions

Satisfaction along six high level interface factors is measured in this section.

PART 4: Screen

This section measures satisfaction with a number of factors related to visual displays, including fonts, highlights, layouts and navigation.

PART 5: Terminology and System Information

This section measures satisfaction with system messages, user feedback, and task related wording that the system generates.

PART 6: Learning

This section measures the user's perception of their ability to learn complex system tasks.

PART 7: System Capabilities

This section measures satisfaction with the system's performance and reliability, both in error recovery and error prevention.

PART 8: Technical Manuals & On-line Help

This section gauges the system's help facilities to determine whether the information presented is of the proper language, scope, and granularity to solve the problems a user is likely to have.

PART 9: On-line Tutorials

This section asks users to rate a number of factors that predict the usefulness of on-line tutorials. Factors include structure, ease of navigation, level of detail, quality of example tasks, and overall effectiveness of the tutorial.

PART 10: Multimedia

This section measures the subjective perception of images, sound, video, and color display within the system across several factors.

PART 11: Teleconferencing

The ease or difficulty of system installation and configuration, the fidelity of the communication, and the ability to share a common experience through distance communication determines the success of a teleconferencing experience. This section gauges the user's subjective satisfaction with these aspects of telecommunication.

PART 12: Software Installation

The speed, difficulty, flexibility, and level of feedback provided during the installation of a system are measured in this section.

How to Use the QUIS™: Some Questions and Answers

Can we omit questions to save time or limit scope?

The hierarchical structure of this questionnaire allows you to be selective in both the coverage and granularity of your inquiry. For this reason, the questionnaire can be as long or as short as your situation requires. There are large sections of the questionnaire that you may have no need to use. Other sections will only need to include the main questions without the sub-questions. In areas that you are particularly interested in, you may choose to include the sub-questions also.

In any case, we recommend that you include the overall measures, as they provide a useful and concise picture of the general usability of your system.

Can we add questions that address our specific needs?

We generally expect that any questions added that are in the "QUIS™ style" will have a reasonable amount of reliability. It is common practice to tune the QUIS™ in this way.

How might the QUIS™ data be analyzed?

Several approaches have been taken in the analysis of QUIS™ data.

Forming Data Sets:

Once the QUIS™™ data has been collected, the first decision is whether to analyze the data as a whole or in groups. Obviously, if you are comparing two different pieces of software you will want to group the data by, say, Software Package A and Software Package B. On the other hand, if you are interested in differences between types of users of the same package, you would group on groups of individuals, say, User Group 1 and User Group 2. When forming data sets, we will be interested in statistics within each group as well as hypotheses tests between groups. Let's first consider the statistics within groups.

Profiles and Diagnostic Tests:

One of the most useful analyses, particularly for iterative testing and design, is the profile. The profile reveals the strengths and weaknesses of the software program or workstation by showing the deviations of the means above and below a criterion. A profile is generated by calculating the means and standard deviations for each item in the QUIS™. The means are then graphed on a scale from 1 to 9 as shown in the figure below:

The midpoint of the rating scale (5) can be used as a criterion. If the item is above 5, it is perceived as being better than an arbitrary, mediocre value. However, that is generally not good enough. We may also use the overall mean of the group as a criterion. Such a mean is shown in the figure.

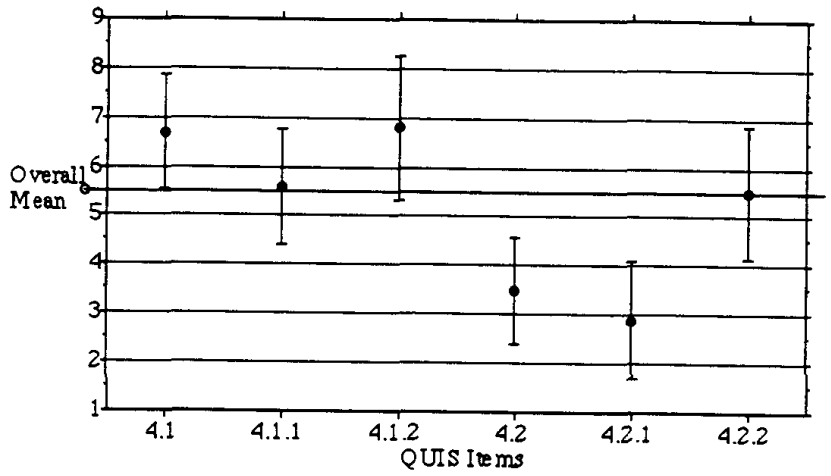

Figure 0-1

It is useful to plot a confidence interval around each mean in order to determine its reliability. The confidence interval also indicates whether the mean of an item is significantly above or below some criterion. For example, if a 95% confidence interval includes 5 within its boundaries, then it indicates that the mean is not significantly different from 5 at the .05 level of significance.

The profile can be used to identify the areas in the application which are particularly good or particularly bad. Start with the item having the lowest mean. Identify flaws in the software that may have led to this low mean. Then go to the next lowest item and repeat. Do this until you are satisfied that you have identified the major problems. Then start with the item having the highest mean. Ask yourself why this aspect was rated so high and how it can be used to further enhance the software. Then go the next highest item and repeat. Again, do this until you are satisfied that you have identified all of the strong points of the software.

A more sensitive and statistically powerful technique for identifying the strengths and weaknesses is to use a within-subject approach. For each respondent, compute a mean of all of his or her ratings. Then for each of the respondent's ratings get the deviation between that rating and the respondent's mean, ($d_{ik} = X_{ik} - M_{.k}$; where X_{ik} is the rating for item *k* by respondent *i* and $M_{i.}$ is the mean for respondent *i* across all items). A simple t-test on these deviations to see if they are significantly different from zero for a particular item will indicate whether the item is perceived as high or low relative to each respondent's average rating. In general, it is nice to have a sample size of at least 20 for statistical purposes. However, realizing that many usability professionals limit their samples to about 10, it is suggested that one avoid statistical tests and generalizations by presenting only means and focusing on the highest and lowest ratings.

Comparing Groups:

When your data is composed of groups, you make comparisons between groups at the overall level and at the level of individual items. However, remember that the more statistical tests you run, the greater your probability of a Type I Error (a spurious result). To guard against that, you should consider only using the .01 or .001 level of significance.

For overall comparisons you may find the mean of the Overall Ratings (3.1 to 3.6) for each respondent in each group. Then compare the group means using a t-test. Means may also be computed for sections of the QUIS™™ or for all of the items on the QUIS™™ and compared between groups. Or, of course, you may make comparisons at the individual item level. But again, beware of Type I Error.

More Sophisticated Analyses:

The number of analyses that one can play with is nearly endless, if you have enough data points. One should be cautious of over-analyzing the data. You will be bound to find something fascinating but unreliable. Nevertheless, some interesting additional analyses can be used to investigate the correlational structure of the items. These analyses can reveal the underlying importance or relevance of items to the users and to overall satisfaction. These include: factor analysis, item analysis, and hierarchical regression analysis.

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APPENDIX D: SURVEY RESULTS

A. QUESTIONNAIRE USED FOR EVALUATION

This questionnaire measured how web-based courses can be rated. The original survey was placed on-line, and due to its size, it was unable to be transferred into this document. To compensate for this, the questionnaire was restructured to reflect the Web version. The survey begins on the following page.

The Instructional Design-Usability Questionnaire

My name is Erich Stefanyshyn and I am a student at the Naval Postgraduate School (NPS) conducting research with Professors Ciavarelli and Darken on:

- Why usability and instructional design principles are not independent of each other when building an on-line course.
- Why the two must be taken into consideration when designing an on-line course for the web.

In order to conduct research, I need your input on how your online class was presented via the web.

Background: System usability and instructional quality are dependent upon each other in web-based instruction. The user may become dissatisfied with an online course because the content is not organized and coherent, even though the computer system is running perfectly. If students spend more time wrestling with the presentation of the subject material rather than the content itself, they begin to divert their attention from the subject material to adjust to the presentation design. As a result, students spend more than the usual amount of required time on a course and become frustrated with long distance education.

Likewise, the content and presentation may be great, but if the system/program functions poorly (low bandwidth, dead-end links, poor user interface etc), the learning process is equally difficult. This defeats the purpose of long distance education that allows students to take the course asynchronously.

Your Help: The above description may (or may not) have happened to you. I would like to know what you considered to be a good course presentation and what you consider bad course presentation.

This is where I need you to rate your class with the Web-based Questionnaire. The Web-Based questionnaire was designed to include both web design and instructional design consideration. **The instructional design relates to the instructor teaching the course, whereas the web design pertains to how the course was designed.**

Your input will be evaluated and analyzed to determine how NPS can improve the quality of its web-based instruction courses.

Outline of the Questionnaire

In order to standardize the web-based instruction at NPS, the questionnaire is broken down into four parts: *Getting the learner Started* section: provides an introduction to the course, course syllabus, objectives, and course expectations. A *Presenting the Subject Material* section: presents the actual course lesson(s). An *Assessing the Subject Material* section: pertains to how well the exams, term papers, projects, etc. were prepared. An *Assessing the Usability of the Courseware* section: rates how well the program (software) ran.

There will be a more detailed explanation in each section so you do not have to come back to this page.

Number of questions: 83 (78 multiple choice and five short (optional) essay)
Time to complete the questionnaire: 20-30 minutes

Thanks for your valuable time and support!

DEMOGRAPHICS

Course

_ SS3011 – Space Systems Technology and Applications, CDR Higgins
_ OC2022 – Scientific Fortran Programming, Arlene Guest
_ MN3384 – Acquisition Production and Quality Management, Mike Boudreau

Was this course delivered

a. Completely online (web-based)
b. Hybrid – some class meetings plus web
c. VTE (video teleconferencing environment) and on-line

PART 1: Getting the Learner Started

This section provides a *"big picture view"* of the course. It assists students by providing a course description, prerequisites for the course, course objectives and goals, navigation of the web site, and instructor biography, a course syllabus (of chapters to read, homework assignments, tests, etc), and course expectations (of the instructor and student).

Before continuing with the course, students should be able to understand course objectives, syllabus, and expectations, and how to access the course lessons.

INSTRUCTIONS

Please circle the numbers, which most appropriately reflect your impressions about this course.

Not Applicable = NA.

Instructional Quality

Course Objectives

1.	Course goals defined	confusing clear 1 2 3 4 5 6 7 8 9	NA
2.	Brief course description	confusing clear 1 2 3 4 5 6 7 8 9	NA
3.	Course prerequisites	confusing clear 1 2 3 4 5 6 7 8 9	NA
4.	Students given instructions/orientation on course navigation	unhelpful helpful 1 2 3 4 5 6 7 8 9	NA
5.	Biography of instructor	unhelpful helpful 1 2 3 4 5 6 7 8 9	NA

Course Syllabus/Class Schedule

6.	Class schedule (when class meets)	confusing clear 1 2 3 4 5 6 7 8 9	NA
7.	Class agenda (amount of reading per week, required assignments due, exam dates)	confusing clear 1 2 3 4 5 6 7 8 9	NA

Course Expectations

8.	Role of the instructor was defined	confusing clear 1 2 3 4 5 6 7 8 9	NA

9. Students' responsibilities confusing clear
1 2 3 4 5 6 7 8 9 NA

10. Grading criteria and procedure confusing clear
1 2 3 4 5 6 7 8 9 NA

Web Design

Course Objectives

11. Content from course objectives (i.e. font, bold, italics, underlines, misspellings, etc) hard to read easy to read
1 2 3 4 5 6 7 8 9 NA

12. Content provided in understandable paragraphs inadequate adequate
1 2 3 4 5 6 7 8 9 NA

13. Content is meaningfully labeled illogical logical
1 2 3 4 5 6 7 8 9 NA

Course Syllabus/Class Schedule

14 Content (i.e. font, bold, italics, underlines, misspellings, etc) hard to read easy to read
1 2 3 4 5 6 7 8 9 NA

15. Content provided in understandable paragraphs inadequate adequate
1 2 3 4 5 6 7 8 9 NA

16. Content is meaningfully labeled illogical logical
1 2 3 4 5 6 7 8 9 NA

Course Expectations

17. Content (i.e. font, bold, italics, underlines, misspellings, etc) hard to read easy to read
1 2 3 4 5 6 7 8 9 NA

18. Content provided in understandable paragraphs inadequate adequate
1 2 3 4 5 6 7 8 9 NA

19. Content is meaningfully labeled illogical logical
1 2 3 4 5 6 7 8 9 NA

20. Please write your comments about the Getting the Learner Started section here:
_____
_____
_____

PART 2: Presenting the Subject Material

The instructor may have organized the material into weekly folders, topic folders, and/or a hyperlink for the week for the student to view or download.

In this area, the number of options for delivering a lesson ranges from purchasing a textbook for the course, additional reading(s) via the web, problems, exercises, discussions via chat rooms and/or discussion boards, written assignments (summaries), and/or extra web-links to enhance the lesson(s). This section evaluates the actual lesson/module. This is where the actual learning begins.

INSTRUCTIONS

Please circle the numbers, which most appropriately reflect your impressions about this course.

Not Applicable = NA.

Instructional Quality

Purpose of the Course

21.	The purpose of each module/section was adequately defined	never always 1 2 3 4 5 6 7 8 9	NA
22.	Learning objectives for each component of the course were adequately defined	never always 1 2 3 4 5 6 7 8 9	NA
23.	Weekly/module folders are in logical order	never always 1 2 3 4 5 6 7 8 9	NA

Instructor's Participation

24.	Students were encouraged to collaborate	never always 1 2 3 4 5 6 7 8 9	NA
25.	Instructor gave learning guidance	never always 1 2 3 4 5 6 7 8 9	NA
26.	Learning guidance was adequate	never always 1 2 3 4 5 6 7 8 9	NA
27.	The instructor responded to students' questions/concerns regarding material	never always 1 2 3 4 5 6 7 8 9	NA

28. Instructor's participation met expectations — never always
1 2 3 4 5 6 7 8 9 NA

Presentation of Subject Material

29. Grading criteria and procedure — difficult easy
1 2 3 4 5 6 7 8 9 NA

30. Instructional material was presented at proper level — difficult easy
1 2 3 4 5 6 7 8 9 NA

31. Instructional explanations of materials — confusing clear
1 2 3 4 5 6 7 8 9 NA

32. Instructional explanations included useful illustrative examples (pictures, graphs, diagrams, etc) — never always
1 2 3 4 5 6 7 8 9 NA

33. Assigned reading related to course objectives — never always
1 2 3 4 5 6 7 8 9 NA

34. Instructional content relevant to learning objectives — never always
1 2 3 4 5 6 7 8 9 NA

35. Instructional content in correct sequence — never always
1 2 3 4 5 6 7 8 9 NA

36. Supplementary web sites provided to enhance learning — never always
1 2 3 4 5 6 7 8 9 NA

37. Subject material was highly interactive — never always
1 2 3 4 5 6 7 8 9 NA

38. Interaction of subject material useful — never always
1 2 3 4 5 6 7 8 9 NA

39. Interaction of subject material useful — never always
1 2 3 4 5 6 7 8 9 NA

40. Content engaged the student in active learning tasks — never always
1 2 3 4 5 6 7 8 9 NA

Assignments for Subject Material

41. Assignment helped achieve learning objectives — never always
1 2 3 4 5 6 7 8 9 NA

42. Review of material was provided — never always
1 2 3 4 5 6 7 8 9 NA

43. Instructional practice examples were provided
never always
1 2 3 4 5 6 7 8 9 NA

44. Discussion board was used during the course
never always
1 2 3 4 5 6 7 8 9 NA

45. Discussion board useful
never always
1 2 3 4 5 6 7 8 9 NA

46. Chat rooms were used during the course
never always
1 2 3 4 5 6 7 8 9 NA

47. Chat rooms useful
never always
1 2 3 4 5 6 7 8 9 NA

48. Written assignments (term papers, one-page Summaries, etc) were included in each assignment
never always
1 2 3 4 5 6 7 8 9 NA

Feedback Section for Students

49. Feedback section on lesson available for students
never always
1 2 3 4 5 6 7 8 9 NA

50. Feedback section on lesson useful
never always
1 2 3 4 5 6 7 8 9 NA

Web Design

51. Subject material content (i.e. font, bold, italics, underlines, misspellings, etc)
hard to read easy to read
1 2 3 4 5 6 7 8 9 NA

52. Subject material content provided in understandable paragraphs
inadequate adequate
1 2 3 4 5 6 7 8 9 NA

53. Content is meaningfully labeled
illogical logical
1 2 3 4 5 6 7 8 9 NA

54. Please write your comments about the Presentation of Subject Material here:

_____
_____
_____
_____
_____
_____

PART 3: Assessing the Subject Material

This section rates the exams, projects, term papers, etc. of the subject material.

INSTRUCTIONS

Please circle the numbers, which most appropriately reflect your impressions about this course.

Not Applicable = NA.

Instructional Quality

55.	Exam questions relevant to learning objectives	never always 1 2 3 4 5 6 7 8 9	NA
56.	Exam questions was presented at proper level	never always 1 2 3 4 5 6 7 8 9	NA
57.	Exam questions are understandable	never always 1 2 3 4 5 6 7 8 9	NA
58.	Exam has a reasonable time limit	never always 1 2 3 4 5 6 7 8 9	NA
59.	Exam provided feedback and review when questions answered incorrectly	never always 1 2 3 4 5 6 7 8 9	NA
60.	Instructional content provided adequate exam preparation	never always 1 2 3 4 5 6 7 8 9	NA
61.	Student critique section of exam provided	never always 1 2 3 4 5 6 7 8 9	NA
62.	Assessments other than exams (papers, projects, assignments, etc) were used in this course)	never always 1 2 3 4 5 6 7 8 9	NA
63.	Assessments relevant to learning objectives	never always 1 2 3 4 5 6 7 8 9	NA

Web Design

64.	Exam content (i.e. font, bold, italics, underlines, misspellings, etc)	hard to read easy to read 1 2 3 4 5 6 7 8 9	NA

65. Exam content provided in understandable paragraphs — inadequate adequate: 1 2 3 4 5 6 7 8 9 NA

66. Content is meaningfully labeled — illogical logical: 1 2 3 4 5 6 7 8 9 NA

67. Please write your comments about the Assessing of Subject Material section here:

_____
_____
_____
_____
_____

PART 4: Assessing the Usability of the Courseware

Courseware is the software program that is used to deliver the course (Blackboard, Cnet, Courseware, etc) online. If the courseware does not function properly (interface, buttons, link time, navigation, runs slow), it may be difficult for the student to concentrate on the material.

Input from students on how the courseware functions, is vital for the success of web-based instruction because if students cannot use it, then the courseware hindered the learning process.

INSTRUCTIONS

Please circle the numbers, which most appropriately reflect your impressions about this course.

Not Applicable = NA.

68. Student critique provided for courseware — never always: 1 2 3 4 5 6 7 8 9 NA

69. Courseware was easy to learn — never always: 1 2 3 4 5 6 7 8 9 NA

70. Courseware was easy to use (after learning it, did you struggle with it for the remainder of the course) — never always: 1 2 3 4 5 6 7 8 9 NA

71. Course site was accessible (connectivity, firewall) — never always: 1 2 3 4 5 6 7 8 9 NA

72. Course site required to much navigation to view actual content (clicking until site reached) — never always: 1 2 3 4 5 6 7 8 9 NA

73. Were there difficulties in navigating from page to page never always
1 2 3 4 5 6 7 8 9 NA

74. Were there difficulties in navigating between lessons never always
1 2 3 4 5 6 7 8 9 NA

75. Were there difficulties in navigating from course page to web links and back to course page never always
1 2 3 4 5 6 7 8 9 NA

76. Were there difficulties in paging from top of page to bottom of page never always
1 2 3 4 5 6 7 8 9 NA

77. Were there difficulties in paging from bottom of page to top of page never always
1 2 3 4 5 6 7 8 9 NA

78. Were there difficulties in finding the "home" page never always
1 2 3 4 5 6 7 8 9 NA

79. Were there difficulties in finding the desired web page (location) never always
1 2 3 4 5 6 7 8 9 NA

80. Speed of Courseware was adequate (waiting a long time to go to next site and for downloads) never always
1 2 3 4 5 6 7 8 9 NA

81. Please write your comments about Assessing the Usability of the Courseware here:

_____
_____
_____
_____
_____

END OF QUESTIONNAIRE !!

Thank you for your cooperation!!

B. GRAPHING OF RESULTS

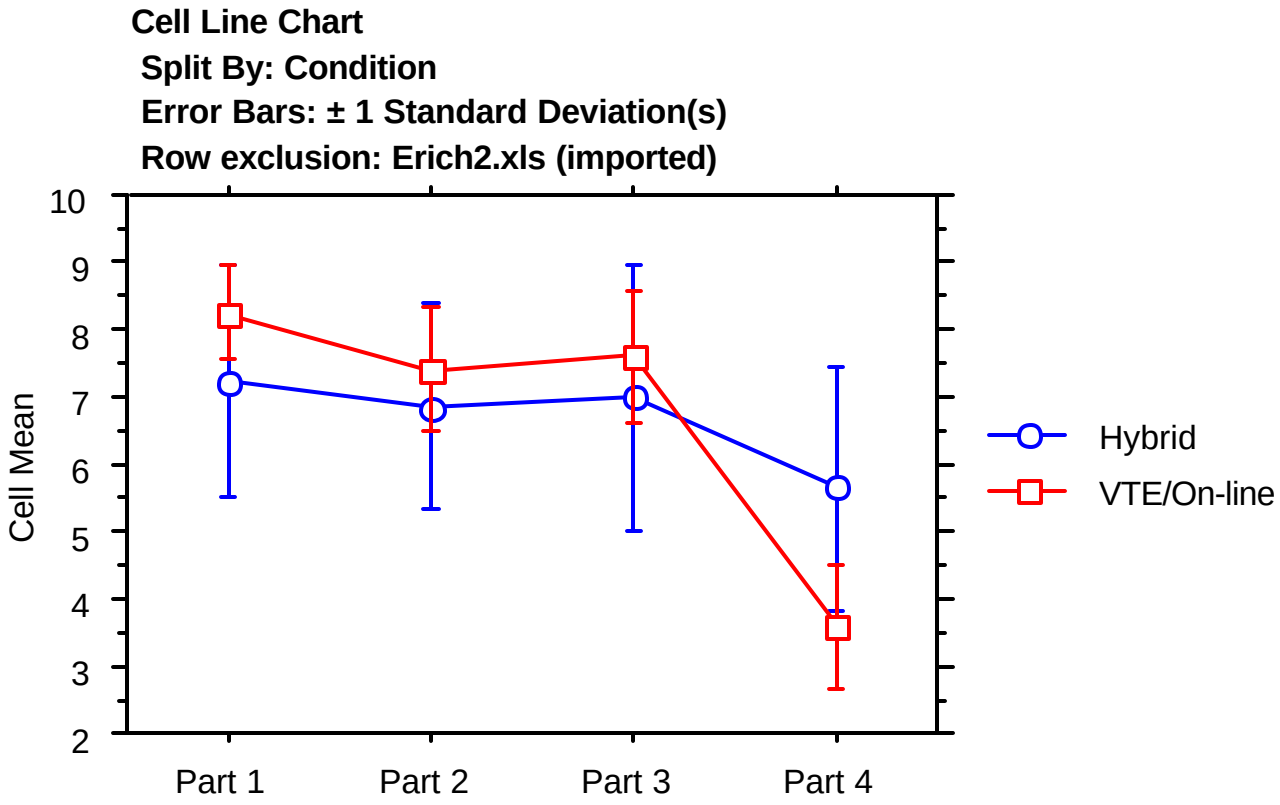
The results from the survey were interpreted measured on Excel spreadsheet and then transferred to the program Stat View for graphing. The purpose of the graphs is to compare the average of the respondents based on the class conditions. The two conditions are:

- Hybrid (class/web-enhanced) and
- VTE (video teleconferencing/web-enhanced).

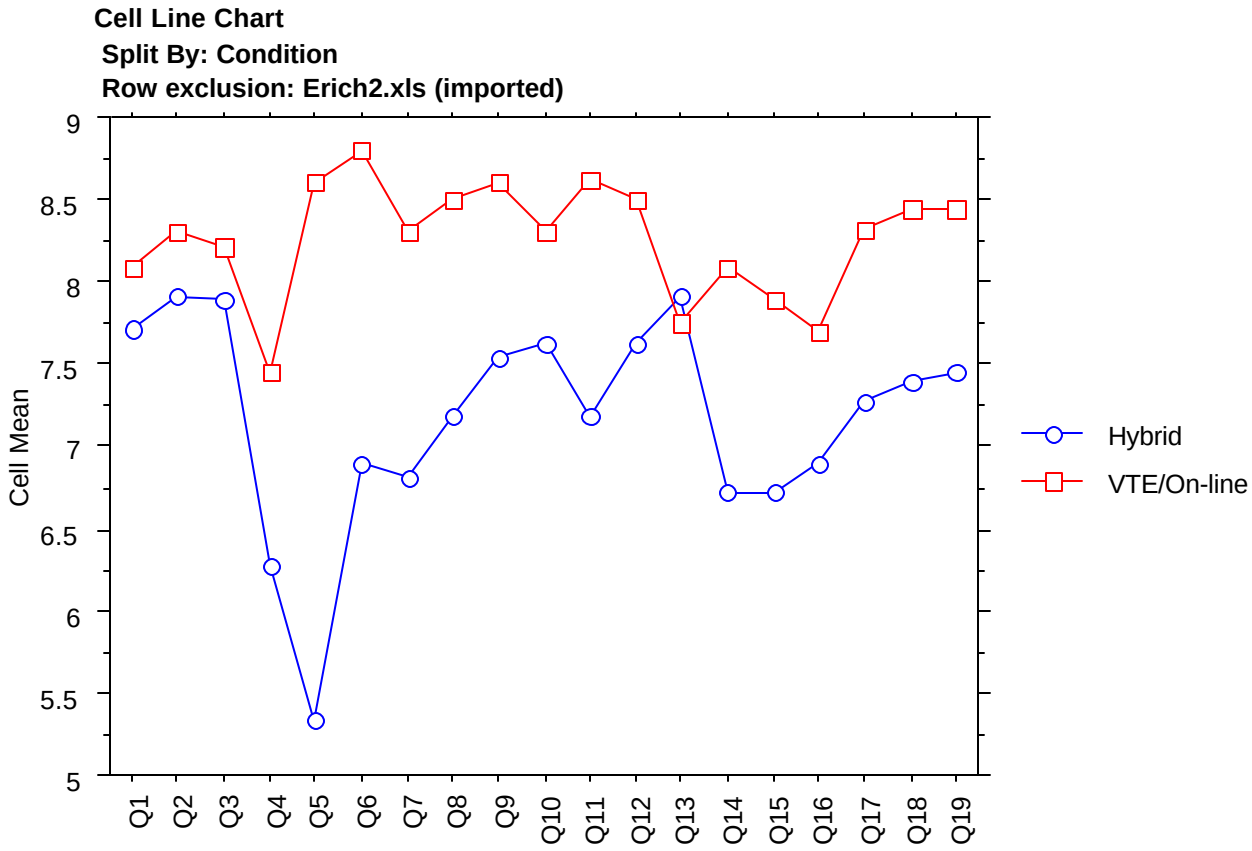
They offer an opportunity to compare not only two different groups, but also the chance of evaluating how well the questionnaire can measure web-based instruction. The results show that the questionnaire does deliver constant results and can measure web-based instruction.

The averages were obtained by the rating system provided by the QUIS 7.0 (APPENDIX C: QUESTIONNAIRE FOR USER INTERACTION SATISFACTION).

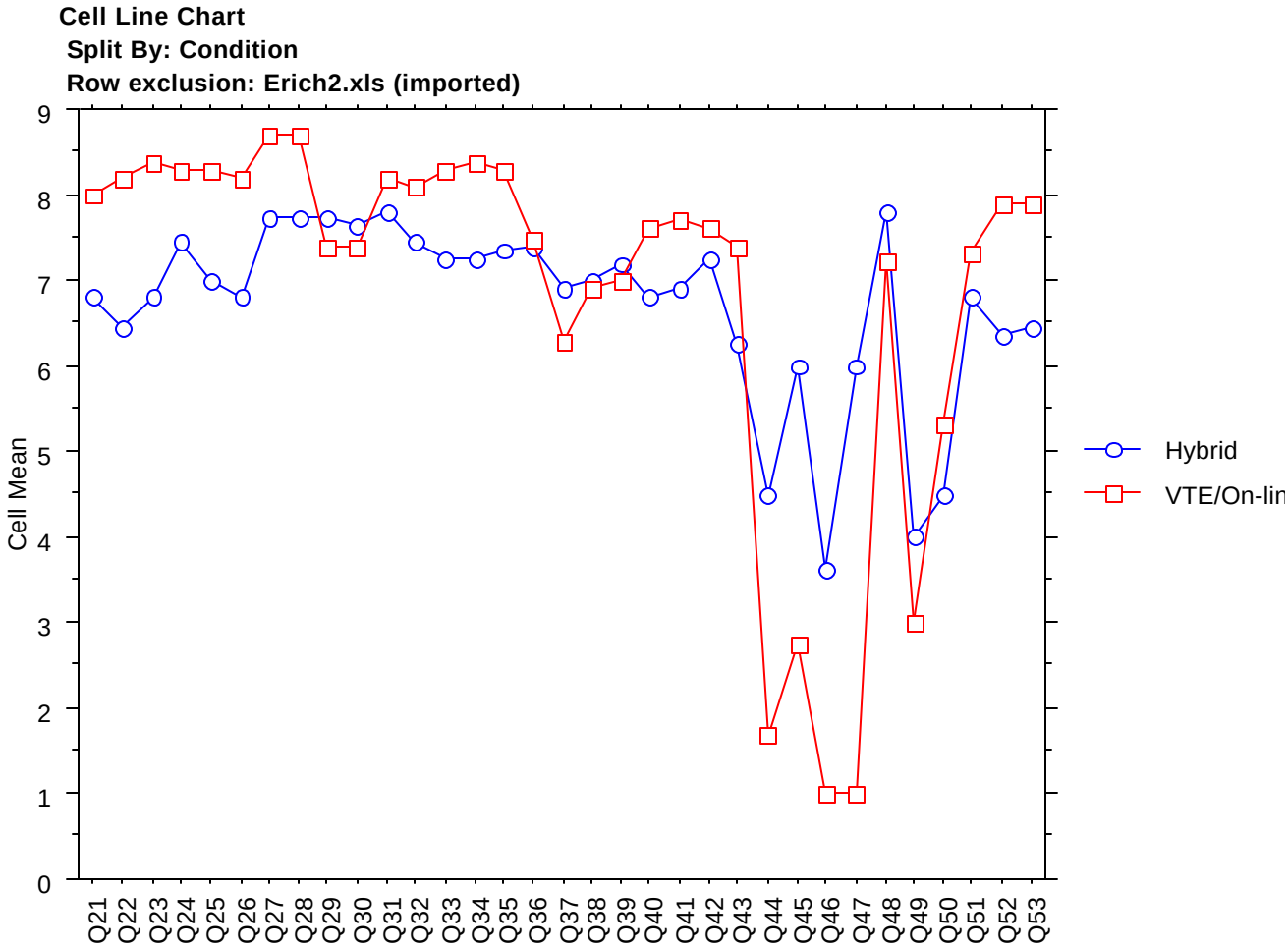
1. **Graph 1: Summary of Areas**



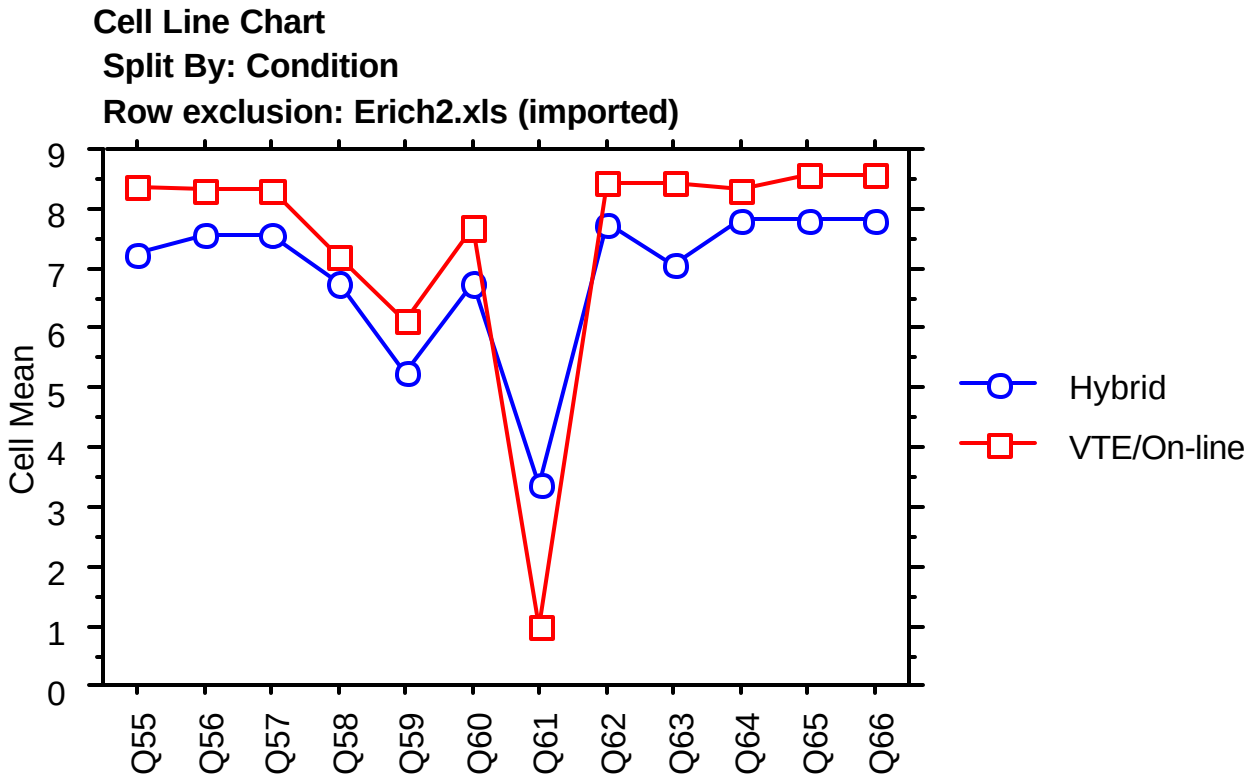
2. Graph 2: Getting the Learner Started



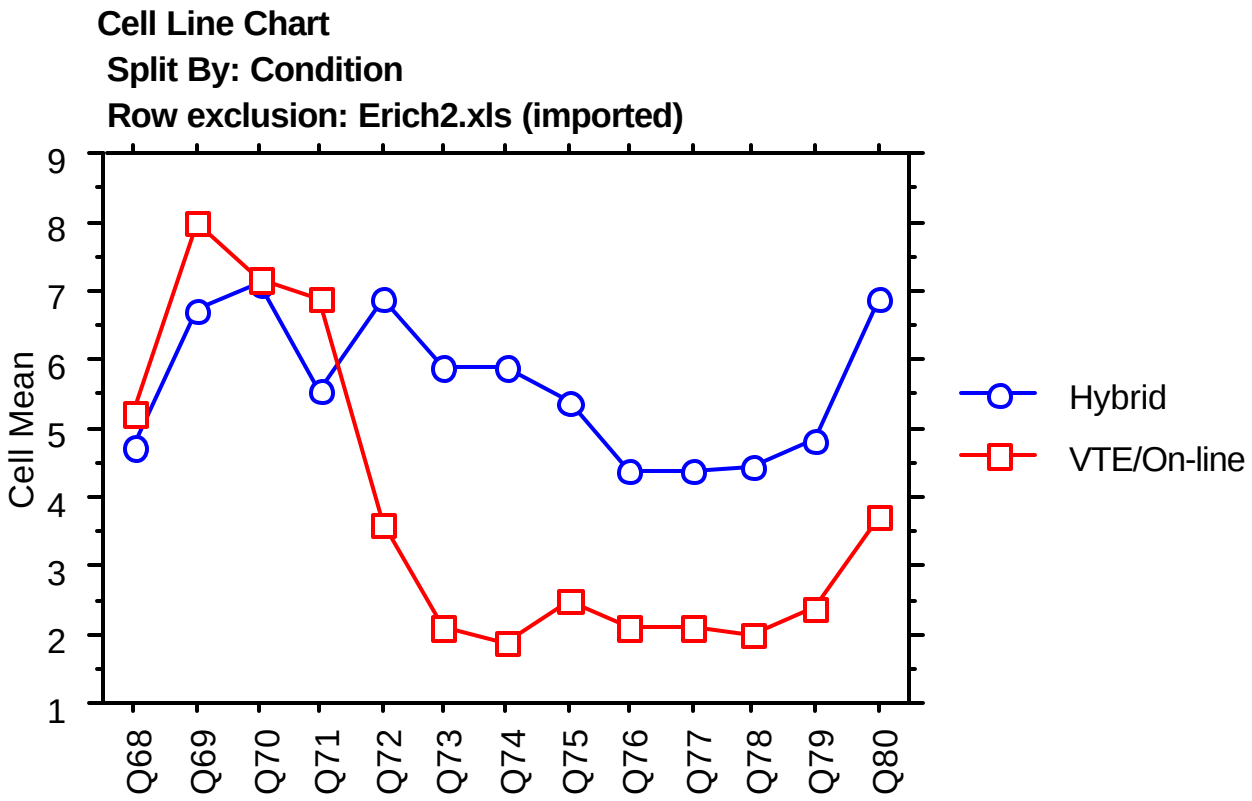
3. Graph 3: Presenting the Subject Material



4. Graph 4: Assessing the Subject Material



5. **Graph 5: Assessing the Usability of the Courseware**



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